

University of Mumbai

PRACTICAL JOURNAL



IT 503

Advance Computer Networks

SUBMITTED BY

(SANALI SANTOSH MUNDHE)

SEAT NO _____

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
QUALIFYING M.Sc.IT (Cloud Computing) PART-I (SEMESTER – I) EXAMINATION

2025-26

DEPARTMENT OF INFORMATION
TECHNOLOGY
2nd FLOOR IT PARK, UNIVERSITY DEPARTMENT OF
INFORMATION TECHNOLOGY,
UNIVERSITY OF MUMBAI, KALINA,
SANTACRUZ (EAST), MUMBAI – 400098

University of Mumbai**Department of Information Technology****Certificate**

This is to certify that Mr./Ms., **Sanali Santosh Mundhe**.

Seat No. _____ Studying in **M.Sc.IT (Cloud Computing) Part I Semester I** has satisfactorily completed the Practical of **503 Advance computer Networks** as prescribed by University of Mumbai, during the academic year **2025 - 26**.

Signature
Subject-In-Charge

Signature
Head of the Department

Signature
External Examiner

College Seal:_____

Date: _____

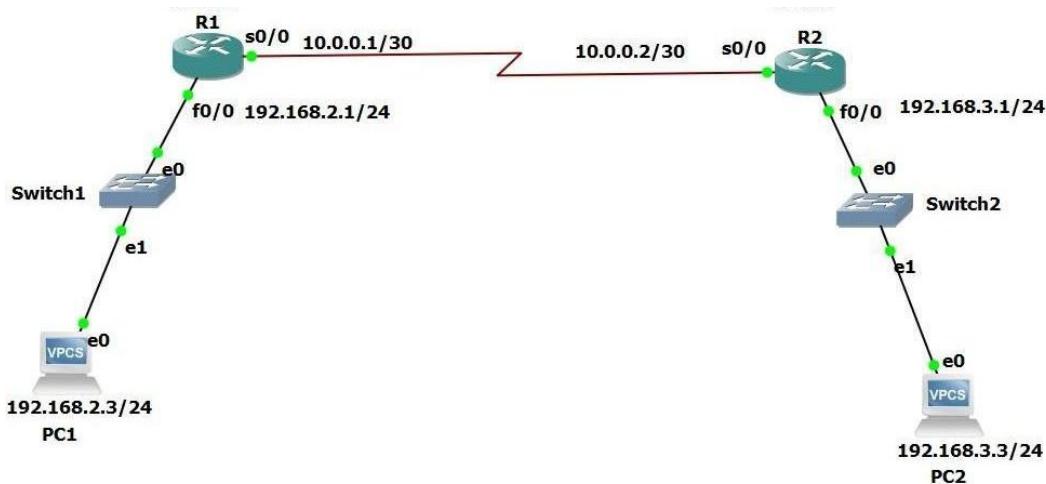
INDEX

Sr. No	Date	Practical	Page No	Sign
1a	05/08/25	Implement the concept of static routing	1-4	
1b	10/09/25	Dynamic Routing Protocol (RIP)	5-7	
2a	10/09/25	Implement the concept of RIPv1 and RIPv2 routing protocol	8-15	
2b	14/09/25	Implementing Dynamic Routing Protocol (OSPF)	16-19	
3a	15/09/25	Implement the concept of OSPF Virtual-Link Configuration	20-25	
3b	22/09/25	Implement the concept OSPF Standard Area and Backbone Area	26-31	
3c	10/10/25	Implement the concept OSPF Stub and Totally Stubby Area	32-37	
4a	15/10/25	Implement the concept of BGP routing protocol	38-49	
4b	07/11/25	Implement the concept of BGP Path Attributes – MED	50-54	
4c	08/11/25	Implement the concept of BGP AS Path Attribute	55-64	
4d	10/11/25	Implement the concept of BGP path Attribute- Local protocol	65-72	

Practical 1a: Implement the concept of static routing

Software Used: GNS3

Here is the Topology on which we did the experiment



Scenario

Suppose that your company has 2 branches located in Tehran and Shiraz.

As the administrator of the network, you are tasked to connect them so that employees in the two LANs can communicate with each other.

After careful consideration you decided to connect them via static route.

Step1. Configuring interfaces on R1

```

R1(Config)#int fa0/0
R1(Config-if)#ip address 192.168.2.1 255.255.255.0
R1(Config-if)#no shutdown
R1(Config-if)#exit
R1(Config)#int
      s0/0
R1(Config-if)#ip address 10.0.0.1 255.255.255.0
R1(Config-if)#no shutdown
R1(Config-if)#clock rate 64000
R1(Config-if)#exit
  
```

```
R1(config)#int f 0/0
R1(config-if)#ip add
R1(config-if)#ip address 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:02:20.951: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:02:21.951: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

```
R1(config)#int s0/0
R1(config-if)#ip addr
R1(config-if)#ip address 10.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#clock
R1(config-if)#clock r
R1(config-if)#clock rate 64000
R1(config-if)#ex
```

Step2.Configure interfaces on R2

```
R1(Config)#int s0/0
R1(Config-if)#ip address 10.0.0.2 255.255.255.252
R1(Config-if)#no shut
R1(Config-if)#clock rate
R1(Config-if)#ex
R1(Config)#int fa0/0
R1(Config-if)#ip address 12.168.3.1 255.255.255.0
R1(Config-if)#no shut
R1(Config-if)#ex
```

```
R2(config)#int s 0/0
R2(config-if)#ip addr
R2(config-if)#ip address 10.0.0.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#clock rate
*Mar 1 00:04:22.7: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R2(config-if)#clock rate
*Mar 1 00:04:46.231: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R2(config-if)#exit
R2(config)#int f 0/0
R2(config-if)#ip addr
R2(config-if)#ip address 12.168.3.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)# ex
R2(config)#
*Mar 1 00:05:28.943: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:05:29.943: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

Step3. show ip route command

```
R1(Config)#do s hip route
```

```
R1(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      10.0.0.0/30 is subnetted, 1 subnets
C          10.0.0.0 is directly connected, Serial0/0
C          192.168.2.0/24 is directly connected, FastEthernet0/0
```

R2(Config)#do s hip route

```
R2(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      10.0.0.0/30 is subnetted, 1 subnets
C          10.0.0.0 is directly connected, Serial0/0
C          192.168.3.0/24 is directly connected, FastEthernet0/0
```

Step4. Configuring static route on R1

R1(Config-if)#ip route 192.168.3.0 255.255.255.0 10.0.0.2

R1(Config-if)#do s hip route

```
R1(config)#ip route 192.168.3.0 255.255.255.0 10.0.0.2

R1(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      10.0.0.0/30 is subnetted, 1 subnets
C          10.0.0.0 is directly connected, Serial0/0
C          192.168.2.0/24 is directly connected, FastEthernet0/0
S          192.168.3.0/24 [1/0] via 10.0.0.2
```

Step5. Configuring static route on R2

R2(Config)#ip route 192.168.2.0 255.255.255.0 10.0.0.1

R2(Config)#do s hip route

```
R2(config)#ip route 192.168.2.0 255.255.255.0 10.0.0.1
```

```
R2(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  10.0.0.0/30 is subnetted, 1 subnets
C        10.0.0.0 is directly connected, Serial0/0
S    192.168.2.0/24 [1/0] via 10.0.0.1
C    192.168.3.0/24 is directly connected, FastEthernet0/0
```

Step6. Manually set an IP on PC1

PC>1 ip 192.168.2.3/24 192.168.2.1

```
PC1> ip 192.168.2.3/24 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.3 255.255.255.0 gateway 192.168.2.1
```

Step7. Manually set an IP on PC2

PC>2 ip 192.168.3.3/24 192.168.3.1

```
PC2> ip 192.168.3.3/24 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.3 255.255.255.0 gateway 192.168.3.1
```

Step8. Try to ping each far end network

PC1>ping 192.168.3.3

PC2>ping 192.168.3.2

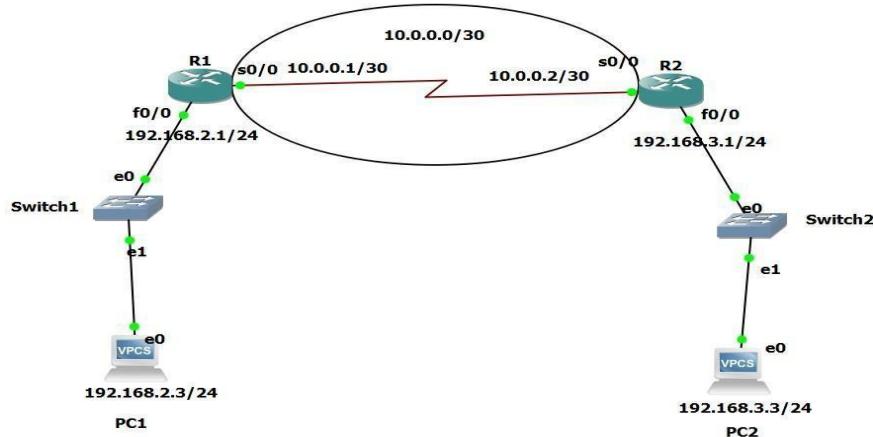
```
PC1> ping 192.168.3.3
192.168.3.3 icmp_seq=1 timeout
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=31.563 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=30.960 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=30.707 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=30.590 ms
```

```
PC2> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=31.296 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=30.814 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=31.184 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=30.092 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=31.135 ms
```

Practical1b: Dynamic Routing Protocol (RIP)

Software Used:GNS3

Here is the topology used for the experiment



Step1. Configuring interfaces on R1

```

R1# conf t
R1(config)#int s 0/0
R1(config-if)#ip address 10.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#ex
R1(config)int f0/0
R1(config-if)#ip address 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
    
```

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s 0/0
R1(config-if)#ip addr 10.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#
*Mar  1 00:04:07.227: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R1(config-if)#
*Mar  1 00:04:08.231: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R1(config)#
R1(config)int f 0/0
R1(config-if)#ip 192.168.2.1 255.255.255.0
R1(config-if)#
*Mar  1 00:04:33.999: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to down
R1(config-if)#
% Invalid input detected at '^' marker.
R1(config-if)#ip addr 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#
R1(config)#
*Mar  1 00:04:55.851: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:04:56.851: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
    
```

Step2. Configure interfaces on R2

```
R1(config)#int s0/0
R1(config-if)#ip address 10.0.0.2 255.255.255.252
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int fa0/0
R1(config-if)#ip address 192.168.3.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
```

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int s 0/0
R2(config-if)#ip addr 10.0.0.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)# ex
R2(config)#
*Mar 1 00:04:27.207: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R2(config)#
*Mar 1 00:04:28.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R2(config)#int f 0/0
R2(config-if)#ip addr
R2(config-if)#ip address
% Incomplete command.

R2(config-if)#ip address 192.168.3.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:04:51.367: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:04:52.367: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

Step3. Manually set an IP on PC1

PC>1 ip 192.168.2.3/24 192.168.2.1

```
PC1> ip 192.168.2.3/24 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.3 255.255.255.0 gateway 192.168.2.1
```

Step4. Manually set an IP on PC2

PC>2 ip 192.168.3.3/24 192.168.3.1

```
PC2> ip 192.168.3.3/24 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.3 255.255.255.0 gateway 192.168.3.1
```

Step5. Configuring static route on R1

```
R1(config)#router rip
R1(config-router)#network 10.0.0.0
R1(config-router)#network 192.168.2.0
R1(config-router)#end
R1#conf t
R1(config)#do sh ip route
```

```

R1(config)#router rip
R1(config-router)#net
R1(config-router)#network 10.0.0.0
R1(config-router)#ne
R1(config-router)#net
R1(config-router)#network 192.168.2.0
R1(config-router)#end
R1#conf
*Mar 1 00:33:40.311: %SYS-5-CONFIG_I: Configured from console by console
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  10.0.0.0/30 is subnetted, 1 subnets
C    10.0.0.0 is directly connected, Serial0/0
C    192.168.2.0/24 is directly connected, FastEthernet0/0

```

Step6. Configuring static route on R2

```

R2(config)#router rip
R2(config-router)#network 10.0.0.0
R2(config-router)#network 192.168.3.0
R2(config-router)#ex
R2(config)#do sh ip route

```

```

R2(config)#router rip
R2(config-router)#net
R2(config-router)#network 10.0.0.0
R2(config-router)#net
R2(config-router)#network 192.168.3.0
R2(config-router)#ex
R2(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  10.0.0.0/30 is subnetted, 1 subnets
C    10.0.0.0 is directly connected, Serial0/0
R    192.168.2.0/24 [120/1] via 10.0.0.1, 00:00:10, Serial0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0

```

Step7.Ping the end PCs

```

PC1>ping 192.168.3.3
PC2>ping 192.168.2.3

```

```

PC1> ping 192.168.3.3
192.168.3.3 icmp_seq=1 timeout
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=31.757 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=30.848 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=31.061 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=31.315 ms

PC2> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=31.179 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=30.927 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=30.951 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=31.357 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=31.011 ms

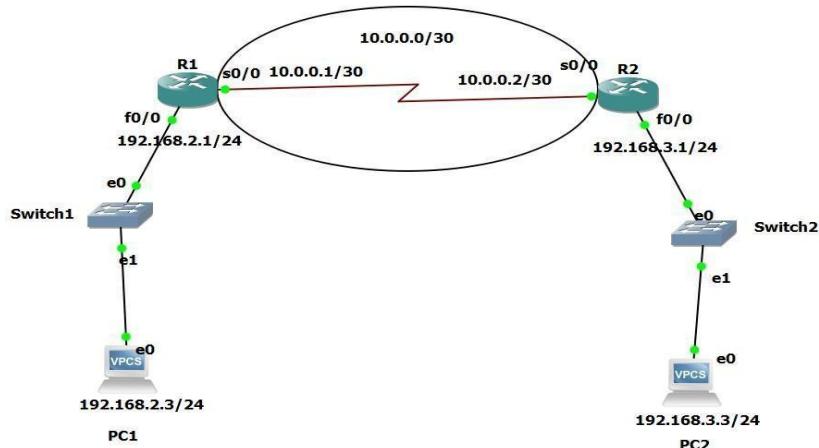
```

Practical 2a: Implement the concept of RIPv1 and RIPv2 routing protocol

RIP v1

Software Used: GNS3

Here is the physical topology



Step1. Configuring interfaces on R1

```
R1#conf t
R1(config)#int s0/0
R1(config-if)#ip address 10.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int fa0/0
R1(config-if)#ip address 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s 0/0
R1(config-if)#ip addr
R1(config-if)#ip address 10.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#
*Mar 1 00:04:07.227: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R1(config-if)#
*Mar 1 00:04:08.231: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R1(config-if)#ex
R1(config)#int f 0/0
R1(config-if)#192.168
*Mar 1 00:04:33.999: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to down
R1(config-if)#192.168.2.1 255.255.255.0
^
% Invalid input detected at '^' marker.

R1(config-if)#ip addr 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:04:55.851: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:04:56.851: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
^
```

Step2.Configure interfaces on R2

```
R2#conf t
R2(config)#int s0/0
R2(config-if)#ip address 10.0.0.2 255.255.255.255
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int fa0/0
R2(config-if)#ip address 192.168.3.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
```

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int s 0/0
R2(config-if)#ip addr 10.0.0.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)# ex
R2(config)#
*Mar 1 00:04:27.207: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R2(config)#
*Mar 1 00:04:28.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R2(config)#int f 0/0
R2(config-if)#ip addr
R2(config-if)#ip address
% Incomplete command.

R2(config-if)#ip address 192.168.3.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:04:51.367: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:04:52.367: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

Step3. Manually set an IP on PC1

PC1> 192.168.2.3/24 192.168.2.1

```
PC1> ip 192.168.2.3/24 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.3 255.255.255.0 gateway 192.168.2.1
```

Step4. Manually set an IP on PC2

PC2> 192.168.3.3/24 192.168.3.1

```
PC2> ip 192.168.3.3/24 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.3 255.255.255.0 gateway 192.168.3.1
```

Step5. Configuring static route on R1

```
R1(config)#router rip
R1(config-router)#neighbor 10.0.0.0
R1(config-router)#neighbor 192.168.2.0
R1(config-router)#end
```

R1(config)#do sh ip route

```
R1(config)#router rip
R1(config-router)#net
R1(config-router)#network 10.0.0.0
R1(config-router)#ne
R1(config-router)#net
R1(config-router)#network 192.168.2.0
R1(config-router)#end
R1#conf
*Mar 1 00:33:40.311: %SYS-5-CONFIG_I: Configured from console by console
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      10.0.0.0/30 is subnetted, 1 subnets
C        10.0.0.0 is directly connected, Serial0/0
C        192.168.2.0/24 is directly connected, FastEthernet0/0
```

Step6. Configuring static route on R2

R2(config)#router rip

R2(config-router)#neighbor 10.0.0.0

R2(config-router)#neighbor 192.168.3.0

R2(config-router)#end

R2(config)#do sh ip route

```
R2(config)#router rip
R2(config-router)#net
R2(config-router)#network 10.0.0.0
R2(config-router)#net
R2(config-router)#network 192.168.3.0
R2(config-router)#ex
R2(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      10.0.0.0/30 is subnetted, 1 subnets
C        10.0.0.0 is directly connected, Serial0/0
R        192.168.2.0/24 [120/1] via 10.0.0.1, 00:00:10, Serial0/0
C        192.168.3.0/24 is directly connected, FastEthernet0/0
```

Step7.Ping the end PCs

PC1> ping 192.168.3.3

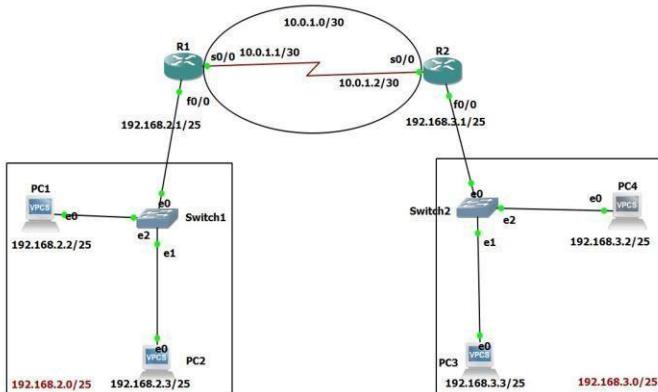
PC2> ping 192.168.2.3

```
PC1> ping 192.168.3.3
192.168.3.3 icmp_seq=1 timeout
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=31.757 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=30.848 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=31.061 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=31.315 ms
```

```
PC2> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=31.179 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=30.927 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=30.951 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=31.357 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=31.011 ms
```

RIPv2

Here is the physical topology



Step1. Configure the router R1

```
R1#conf t
R1(config)#int s0/0
R1(config-if)#ip address 10.0.1.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int fa0/0
R1(config-if)#ip address 192.168.2.1 255.255.255.128
R1(config-if)#no shut
R1(config-if)#ex
R1(config-if)#do sh ip int br
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s0/0
R1(config-if)#ip add
R1(config-if)#ip address 10.0.1.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:01:20.079: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R1(config)#int f0/0
R1(config-if)#ip add
R1(config-if)#ip address 192.168.2.1 255.255.255.128
*Mar 1 00:01:44.919: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to down
R1(config-if)#ip address 192.168.2.1 255.255.255.128
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:01:51.819: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:52.819: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#
*Mar 1 00:02:24.915: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R1(config)#do sh ip int br
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    192.168.2.1    YES manual up        up
Serial0/0          10.0.1.1     YES manual up        up
FastEthernet0/1    unassigned     YES unset administratively down down
Serial0/1          unassigned     YES unset administratively down down
Serial0/2          unassigned     YES unset administratively down down
Serial0/3          unassigned     YES unset administratively down down
FastEthernet1/0    unassigned     YES unset administratively down down
```

Step2. Configure the Router R2

```
R2#conf t
R2(config)#int s0/0
R2(config-if)#ip address 10.0.1.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int fa0/0
R2(config-if)#ip address 192.168.3.1 255.255.255.128
R2(config-if)#no shut
R2(config-if)#ex
R2(config-if)#do sh ip int br
```

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int s0/0
R2(config-if)#ip addr
R2(config-if)#ip address 10.0.1.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:01:40.627: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
*Mar 1 00:01:41.631: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R2(config)#int f0/0
R2(config-if)#ip addr
R2(config-if)#ip address 192.168.3.1 255.255.255.128
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:02:02.259: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:02:03.259: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#do sh ip int br
ip sh int br
^
% Invalid input detected at '^' marker.

R2(config)#do sh ip int br
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    192.168.3.1    YES manual up        up
Serial0/0          10.0.1.2     YES manual up        up
FastEthernet0/1    unassigned     YES unset administratively down down
Serial0/1          unassigned     YES unset administratively down down
```

Step3. Configure the PC1, PC2, PC3, PC4

PC1>ip 192.168.2.2/25 192.168.2.1

PC2>ip 192.168.2.3/25 192.168.2.1

PC3>ip 192.168.3.3/25 192.168.3.1

PC4>ip 192.168.3.2/25 192.168.3.1

```
PC1> ip 192.168.2.2/25 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.2 255.255.255.128 gateway 192.168.2.1
```

```
PC2> ip 192.168.2.3/25 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.3 255.255.255.128 gateway 192.168.2.1
```

```
PC3> ip 192.168.3.3/25 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.3 255.255.255.128 gateway 192.168.3.1
```

```
PC4> ip 192.168.3.2/25 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.2 255.255.255.128 gateway 192.168.3.1
```

Step4. Configure the RIP protocol in the R1

R1(config)#router rip

R1(config-router)#version 2

R1(config-router)#neighbor 10.0.1.0

R1(config-router)#neighbor 192.168.2.0

R1(config-router)#ex

```
R1(config)#router rip
R1(config-router)#vers
R1(config-router)#version 2
R1(config-router)#net
R1(config-router)#network
R1(config-router)#network 10.0.1.0
R1(config-router)#net
R1(config-router)#network 192.168.2.0
R1(config-router)#exit
```

Step5.Configure RIP protocol in the R2

R2(config)#router rip

R2(config-router)#version 2

R2(config-router)#neighbor 10.0.1.0

R2(config-router)#neighbor 192.168.3.0 R2(config- router)#ex

```
R2(config)#router rip
R2(config-router)#version 2
R2(config-router)#net
R2(config-router)#network 10.0.1.0
R2(config-router)#network 192.168.3.0
R2(config-router)#exit
```

Step6. Show IP route command in R1 and R2

R1(config)#do s hip route

```
R1(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  10.0.0.0/30 is subnetted, 1 subnets
C       10.0.1.0 is directly connected, Serial0/0
  192.168.2.0/25 is subnetted, 1 subnets
C       192.168.2.0 is directly connected, FastEthernet0/0
R   192.168.3.0/24 [120/1] via 10.0.1.2, 00:00:07, Serial0/0
```

R2(config)#do sh ip route

```
R2(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  10.0.0.0/30 is subnetted, 1 subnets
C       10.0.1.0 is directly connected, Serial0/0
R   192.168.2.0/24 [120/1] via 10.0.1.1, 00:00:17, Serial0/0
  192.168.3.0/25 is subnetted, 1 subnets
C       192.168.3.0 is directly connected, FastEthernet0/0
```

Step7.ping with the end PCs

PC1> ping 192.168.3.2	PC1> ping 192.168.3.3
PC2> ping 192.168.3.3	PC2> ping 192.168.3.2
PC3> ping 192.168.2.3	PC3> ping 192.168.2.2
PC4> ping 192.168.2.3	PC4>
ping 192.168.2.2	

```
PC1> ping 192.168.3.2
192.168.3.2 icmp_seq=1 timeout
84 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=30.972 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=62 time=31.203 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=31.540 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=31.269 ms

PC1> ping 192.168.3.3
192.168.3.3 icmp_seq=1 timeout
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=30.764 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=30.701 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=30.659 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=31.199 ms
```

```
PC2> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=62 time=31.148 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=31.654 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=31.288 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=31.300 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=31.690 ms
```

```
PC3> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=30.977 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=31.545 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=30.944 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=30.524 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=30.775 ms

PC3> ping 192.168.2.2
Cannot resolve 192.168.2.2

PC3> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=62 time=30.619 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=62 time=31.188 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=62 time=31.602 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=62 time=32.549 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=62 time=30.971 ms
```

```
PC4> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=31.234 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=31.438 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=31.760 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=31.730 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=30.290 ms
```

```
PC4> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=62 time=31.594 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=62 time=31.895 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=62 time=30.996 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=62 time=30.980 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=62 time=31.051 ms
```

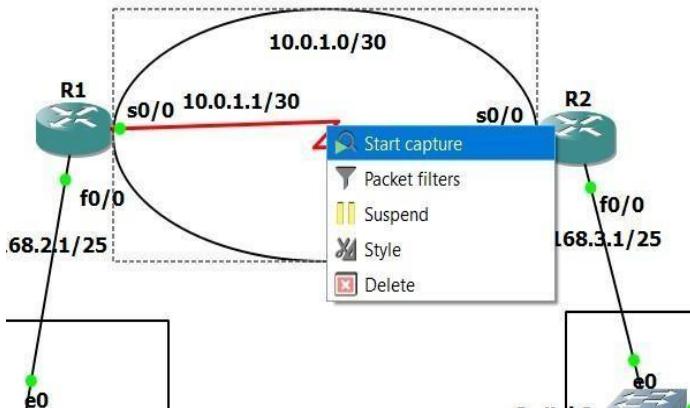
Step8. On Router R2, execute the debug IP rip command to check the RIPv2 configuration and you will see a log as shown in the image below.

R2(config)#do debug ip rip

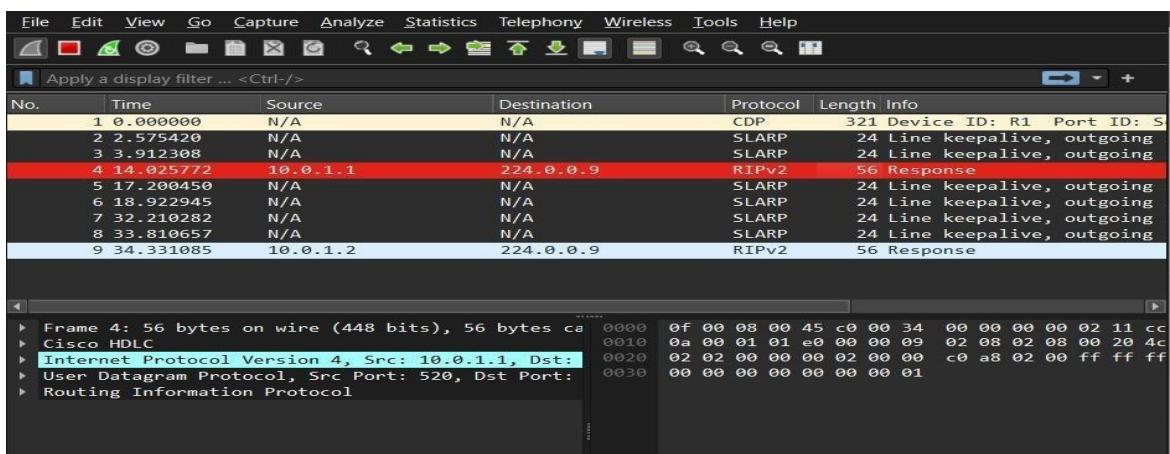
```
R2(config)#do debug ip rip
RIP protocol debugging is on
R2(config)#
*Mar 1 00:17:43.371: RIP: sending v2 update to 224.0.0.9 via Serial0/0 (10.0.1.2)
*Mar 1 00:17:43.371: RIP: build update entries
*Mar 1 00:17:43.371: 192.168.3.0/24 via 0.0.0.0, metric 1, tag 0
R2(config)#
*Mar 1 00:17:46.491: RIP: sending v2 update to 224.0.0.9 via FastEthernet0/0 (192.168.3.1)
*Mar 1 00:17:46.491: RIP: build update entries
*Mar 1 00:17:46.491: 10.0.0.8 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:17:46.495: 192.168.2.0/24 via 0.0.0.0, metric 2, tag 0
R2(config)#
*Mar 1 00:17:54.767: RIP: received v2 update from 10.0.1.1 on Serial0/0
*Mar 1 00:17:54.767: 192.168.2.0/24 via 0.0.0.0 in 1 hops
R2(config)#
*Mar 1 00:18:12.207: RIP: sending v2 update to 224.0.0.9 via Serial0/0 (10.0.1.2)
*Mar 1 00:18:12.207: RIP: build update entries
*Mar 1 00:18:12.207: 192.168.3.0/24 via 0.0.0.0, metric 1, tag 0
R2(config)#undeb
*Mar 1 00:18:16.267: RIP: sending v2 update to 224.0.0.9 via FastEthernet0/0 (192.168.3.1)
*Mar 1 00:18:16.267: RIP: build update entries
*Mar 1 00:18:16.267: 10.0.0.8 via 0.0.0.0, metric 1, tag 0
*Mar 1 00:18:16.267: 192.168.2.0/24 via 0.0.0.0, metric 2, tag 0
R2(config)#undeb ip rip
^
% Invalid input detected at '^' marker.

R2(config)#do undeb ip rip
RIP protocol debugging is off
```

Step9. We can use the Wireshark program to verify RIPv2. Start the Wireshark program I in between Serial communication line. We can view the RIPv2 (224.0.0.9) output from the image below. After clicking on Start capture the next screen opens



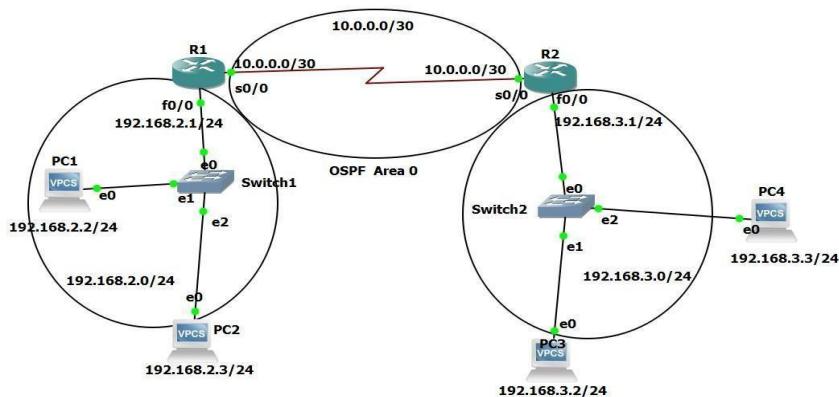
In this screen we can see RIPv2 output on the destination 224.0.0.9



Practical2b: Implementing Dynamic Routing Protocol (OSPF)

Software Used: GNS3

Here is the Physical topology



Step 1. Configure the R1

```
R1#conf t
```

```
R1(config)#int s0/0
```

```
R1(config-if)#ip address 10.0.0.1 255.255.255.252
```

```
R1(config-if)#no shut
```

```
R1(config-if)#ex
```

```
R1(config)#int fa0/0
```

```
R1(config-if)#ip address 192.168.2.1 255.255.255.0
```

```
R1(config-if)#no shut
```

```
R1(config-if)#ex
```

```
R1(config-if)#do sh ip int br
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s0/0
R1(config-if)#ip addr
R1(config-if)#ip address 10.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int
*Mar 1 00:01:27.499: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R1(config)#int
*Mar 1 00:01:28.503: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R1(config)#int f 0/0
R1(config-if)#ip addr 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:01:45.543: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:46.543: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#
*Mar 1 00:02:04.763: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R1(config)#
R1(config)#do sh ip int br
Interface          IP-Address      OK? Method Status        Protocol
FastEthernet0/0    192.168.2.1    YES manual up         up
Serial0/0          10.0.0.1       YES manual up         up
```

Step 2. Configure the R2

```
R2#conf t
R2(config)#int s0/0
R2(config-if)#ip address 10.0.0.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int fa0/0
R2(config-if)#ip address 192.168.3.1 255.255.255.0
R2(config-if)#no shut
```

```
R2(config-if)#ex
R2(config-if)#do sh ip int br
```

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int s 0/0
R2(config-if)#ip addr 10.0.0.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:01:42.675: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R2(config)#int f 0/0
*Mar 1 00:01:43.679: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R2(config-if)#ip addr 192.168.3.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:01:58.327: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:59.327: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#do sh ip int br
Interface          IP-Address      OK? Method Status        Protocol
FastEthernet0/0    192.168.3.1    YES manual up           up
Serial0/0          10.0.0.2       YES manual up           up
FastEthernet0/1    unassigned     YES unset administratively down down
Serial0/1          unassigned     YES unset administratively down down
Serial0/2          unassigned     YES unset administratively down down
```

Step 3. Configure the PC1, PC2, PC3, PC4

```
PC1> ip 192.168.2.2/24 192.168.2.1
PC2> ip 192.168.2.3/24 192.168.2.1
PC3> ip 192.168.3.2/24 192.168.3.1
PC4> ip 192.168.3.3/24 192.168.3.1
```

```
PC1> ip 192.168.2.2/24 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.2 255.255.255.0 gateway 192.168.2.1
```

```
PC3> ip 192.168.3.2/24 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.2 255.255.255.0 gateway 192.168.3.1
```

```
PC2> ip 192.168.2.3/24 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.3 255.255.255.0 gateway 192.168.2.1
```

```
PC4> ip 192.168.3.3/24 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.3 255.255.255.0 gateway 192.168.3.1
```

Step 4. Configure the OSPF area 0 on Router R1 and R2

R1

```
R1(config)#router ospf 10
```

```
R1(config-router)#network 192.168.2.0 0.0.0.255 area 0
```

```
R1(config-router)#network 10.0.0.0 0.0.0.3 area 0
```

```
R1(config-router)#ex
```

```
R1(config)#do sh ip route
```

```
R1(config)#router ospf 10
R1(config-router)#net
R1(config-router)#network 192.168.2.0 0.0.0.255 area 0
R1(config-router)#network 10.0.0.0 0.0.0.3 area 0
R1(config-router)#exit
R1(config)#
*Mar 1 00:07:20.267: %OSPF-5-ADJCHG: Process 10, Nbr 192.168.3.1 on Serial0/0 from LOADING to FULL, Loading Done
R1(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  10.0.0.0/30 is subnetted, 1 subnets
C    10.0.0.0 is directly connected, Serial0/0
C  192.168.2.0/24 is directly connected, FastEthernet0/0
O  192.168.3.0/24 [110/74] via 10.0.0.2, 00:00:32, Serial0/0
```

```
R2(config)#router ospf 10
```

```
R2(config-router)#network 192.168.3.0 0.0.0.255 area 0
```

```
R2(config-router)#network 10.0.0.0 0.0.0.3 area 0
```

```
R2(config-router)#ex
```

```
R2(config)#do sh ip route
```

```
R2(config)#router ospf 10
R2(config-router)#net
R2(config-router)#network 10.0.0.0 0.0.0.3 area 0
R2(config-router)#exit
R2(config)#
*Mar 1 00:06:00.247: %OSPF-5-ADJCHG: Process 10, Nbr 192.168.2.1 on Serial0/0 from LOADING to FULL, Loading Done
R2(config-router)#network 192.168.3.0 0.0.0.255 area 0
R2(config-router)#ex
R2(config)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  10.0.0.0/30 is subnetted, 1 subnets

C    10.0.0.0 is directly connected, Serial0/0
O  192.168.2.0/24 [110/74] via 10.0.0.1, 00:00:24, Serial0/0
C  192.168.3.0/24 is directly connected, FastEthernet0/0
R2(config)#[
```

Step 5. Show the ospf neighbor and OSPF database

```
R1(config)#do sh ip ospf neighbor
```

```
R1(config)#do sh ip ospf neighbor
Neighbor ID      Pri  State          Dead Time     Address           Interface
192.168.3.1      0    FULL/ -        00:00:30     10.0.0.2       Serial0/0
R1(config)#do sh ip ospf database
      OSPF Router with ID (192.168.2.1) (Process ID 10)
      Router Link States (Area 0)

      Link ID      ADV Router      Age      Seq#      Checksum Link count
      192.168.2.1  192.168.2.1  103      0x80000003 0x00D4EF 3
      192.168.3.1  192.168.3.1  84       0x80000002 0x00B70B 3
```

Step 6. Start the debugging

R1(config)#do debug ip ospf packet

```
R1(config)#do debug ip ospf packet
OSPF packet debugging is on
R1(config)#
*Mar 1 00:10:50.247: OSPF: rcv. v:2 t:1 l:48 rid:192.168.3.1
    aid:0.0.0.0 chk:654B aut:0 auk: from Serial0/0
R1(config)#
*Mar 1 00:11:00.215: OSPF: rcv. v:2 t:1 l:48 rid:192.168.3.1
    aid:0.0.0.0 chk:654B aut:0 auk: from Serial0/0
```

Step 7. Ping PC1 to PC4

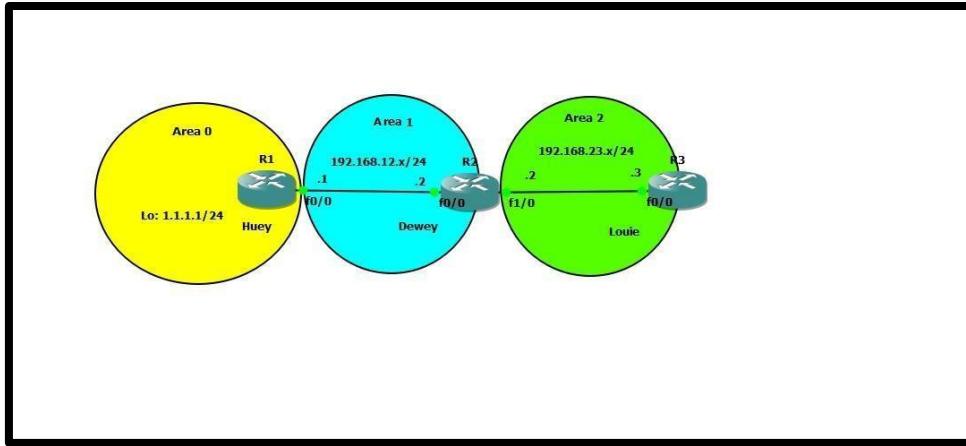
PC1>ping 192.168.3.3

```
PC1> ping 192.168.3.3
192.168.3.3 icmp_seq=1 timeout
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=31.006 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=30.960 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=31.083 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=30.447 ms
```

Step 8. Switch off the Debugging mode

R1(config)#do undebug ip ospf packet

```
R1(config)#do undebug ip ospf packet
*Mar 1 00:11:10.235: OSPF: rcv. v:2 t:1 l:48 rid:192.168.3.1
    aid:0.0.0.0 chk:654B aut:0 auk: from Serial0/0
R1(config)#do undebug ip ospf packet
OSPF packet debugging is off
```

Practical 3a - Implement the concept of OSPF Virtual-Link Configuration**Software Used: GNS3**

```
R1#conf t  
R1(config)#ip cef  
R1(config)#int la0  
R1(config-if)#ip address 1.1.1.1 255.255.255.0  
R1(config-if)#no shut  
R1(config-if)#ex  
R1(config)#int fa0/0  
R1(config-if)#ip address 192.168.12.1 255.255.255.0  
R1(config-if)#no shut  
R1(config-if)#duplex auto  
R1(config-if)#speed auto  
R1(config-if)#ex
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip cef
R1(config)#int lo0
R1(config-if)#ip a
*Mar 1 00:00:28.387: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
changed state to up
R1(config-if)#ip address 1.1.1.1 255.255.255.0
R1(config-if)#ex
R1(config)#int fa 0/0
R1(config-if)#ip address 192.168.12.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#duplex a
*Mar 1 00:01:52.643: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
o up
*Mar 1 00:01:53.643: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet
0/0, changed state to up
R1(config-if)#duplex auto
R1(config-if)#speed auto
R1(config-if)#ex
R1(config)#end
R1#sh
```

R1#conf t

R2(config)#ip cef

R2(config)#int la0

R2(config-if)#{}

R2(config-if)#ex

R2(config)#int fa0/0

R2(config-if)#ip address 192.168.12.2 255.255.255.0

R2(config-if)#no shut

R2(config-if)#duplex auto

R2(config-if)#speed auto

R2(config-if)#ex

R2(config)#int fa1/0

R2(config-if)#ip address 192.168.23.2 255.255.255.0

R2(config-if)#no shut

R2(config-if)#duplex auto

R2(config-if)#speed auto

R2(config-if)#ex

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#ip cef
R2(config)#int lo0
R2(config-if)#
R2(config-if)#
*Mar 1 00:01:24.799: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
changed state to up
R2(config-if)#ex
R2(config)#int fa 0/0
R2(config-if)#ip address 192.168.12.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#duplex
*Mar 1 00:02:03.619: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
o up
*Mar 1 00:02:04.619: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#duplex auto
R2(config-if)#speed auto
R2(config-if)#ex
R2(config)#int fa 1/0
R2(config-if)#ip address 192.168.23.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#dup
*Mar 1 00:03:00.359: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to
o up
*Mar 1 00:03:01.359: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R2(config-if)#duplex auto
R2(config-if)#speed auto
R2(config-if)#ex
R2(config)#end
R2#

```

R3#conf t

R3(config)#ip cef

R3(config)#int la0

R3(config-if)#ip address 172.16.0.1 255.255.255.0

R3(config-if)#no shut

R3(config-if)#ex

R3(config)#int la1

R3(config-if)#ip address 172.16.1.1 255.255.255.0

R3(config-if)#no shut

R3(config-if)#ex

R3(config)#int la2

R3(config-if)#ip address 172.16.2.1 255.255.255.0

R3(config-if)#no shut

R3(config-if)#ex

R3(config)#int la3

R3(config-if)#ip address 172.16.3.1 255.255.255.0

R3(config-if)#no shut

R3(config-if)#ex

R3(config)#int fa0/0

R3(config-if)#ip address 192.168.23.3 255.255.255.0

R3(config-if)#no shut

R3(config-if)#duplex auto

R3(config-if)#speed auto

R3(config-if)#ex

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#ip cef
R3(config)#int lo0
R3(config-if)#
*Mar 1 00:12:22.627: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
changed state to up
R3(config-if)#ip address 172.16.0.1 255.255.255.0
R3(config-if)#ex
R3(config)#int lo1
R3(config-if)#
*Mar 1 00:13:44.039: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1,
changed state to up
R3(config-if)#ip address 172.16.1.1 255.255.255.0
R3(config-if)#ex
R3(config)#int lo2
R3(config-if)#
*Mar 1 00:14:38.963: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2,
changed state to up
R3(config-if)#ip address 172.16.2.1 255
% Incomplete command.

R3(config-if)#ip address 172.16.2.1 255.255.255.0
R3(config-if)#ex
R3(config)#int lo3
R3(config-if)#
*Mar 1 00:15:36.067: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback3,
changed state to up
R3(config-if)#ip address 172.16.3.1 255.255.255.0
R3(config-if)#ex
R3(config)#int fa 0/0
R3(config-if)#ip address 192.168.23.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#duplex
*Mar 1 00:16:36.827: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
up
*Mar 1 00:16:37.827: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
R3(config-if)#duplex auto
R3(config-if)#speed auto
R3(config-if)#ex
(R3(config)#end
R3#s
```

R1#show ip route

```
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet0/0
      1.0.0.0/24 is subnetted, 1 subnets
C      1.1.1.0 is directly connected, Loopback0
R1#
```

K2#show ip route

```
R2#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet0/0
C    192.168.23.0/24 is directly connected, FastEthernet1/0
R2#
```

R3#show ip route

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      172.16.0.0/24 is subnetted, 4 subnets
C        172.16.0.0 is directly connected, Loopback0
C        172.16.1.0 is directly connected, Loopback1
C        172.16.2.0 is directly connected, Loopback2
C        172.16.3.0 is directly connected, Loopback3
C        192.168.23.0/24 is directly connected, FastEthernet0/0

R3#
```

R1(config)#router ospf 1

R1(config-router)#network 192.168.12.0 0.0.0.255 area 1

R1(config-router)#network 1.1.1.0 0.0.0.255 area 0

R1(config-router)#ex

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#network 1.1.1.0 0.0.0.255 area 0
R1(config-router)#network 192.168.12.0 0.0.0.255 area 1
R1(config-router)#
*Mar 1 00:20:44.955: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.23.2 on FastEtherne
t0/0 from LOADING to FULL, Loading Done
R1(config-router)#ex
R1(config)#end
R1#d
R2(config)#router ospf 1
```

R2(config-router)#network 192.168.12.0 0.0.0.255 area 1

R2(config-router)#network 192.168.23.0 0.0.0.255 area 2

R2(config-router)#ex

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.12.0 0.0.0.255 area 1
R2(config-router)#
*Mar 1 00:19:11.003: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on FastEthernet0/0
from LOADING to FULL, Loading Done
R2(config-router)#network 192.168.23.0 0.0.0.255 area 2
R2(config-router)#
*Mar 1 00:21:22.171: %OSPF-5-ADJCHG: Process 1, Nbr 172.16.3.1 on FastEthernet1
/0 from LOADING to FULL, Loading Done
R2(config-router)#ex
```

R3(config)#router ospf 1

R3(config-router)#network 192.168.23.0 0.0.0.255 area 2

R3(config-router)#ex

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router ospf 1
R3(config-router)#network 192.168.23.0 0.0.0.255 area 2
R3(config-router)#
*Mar 1 00:29:46.655: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.23.2 on FastEtherne
t0/0 from LOADING to FULL, Loading Done
R3(config-router)#ex
```

R1# Show ip ospf neighbor

```
R1#show ip ospf neighbor
      -----
      Neighbor ID      Pri      State          Dead Time     Address           Interface
      192.168.23.2      1      FULL/BDR       00:00:35    192.168.12.2   FastEthernet0/
      0
R1#S
```

R2# Show ip ospf neighbor

```
R2(config)#do show ip ospf neighbor
Neighbor ID      Pri   State          Dead Time    Address           Interface
1.1.1.1          1     FULL/DR        00:00:37    192.168.12.1   FastEthernet0/
0
172.16.3.1       1     FULL/BDR       00:00:37    192.168.23.3   FastEthernet1/
```

R3# Show ip ospf neighbor

```
R3(config)#do show ip ospf neighbor
Neighbor ID      Pri   State          Dead Time    Address           Interface
192.168.23.2    1     FULL/DR        00:00:30    192.168.23.2   FastEthernet0/
0
```

Virtual link R1#conf

t

R1(config)#router ospf 1

R1(config-router)#area 1 virtual-link 192.168.23.2

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#area 1 virtual-link 192.168.23.2
R1(config-router)#
*Mar 1 00:31:30.071: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.23.2 on OSPF_VL0 from LOADING to FULL, Loading Done
R1(config-router)#

```

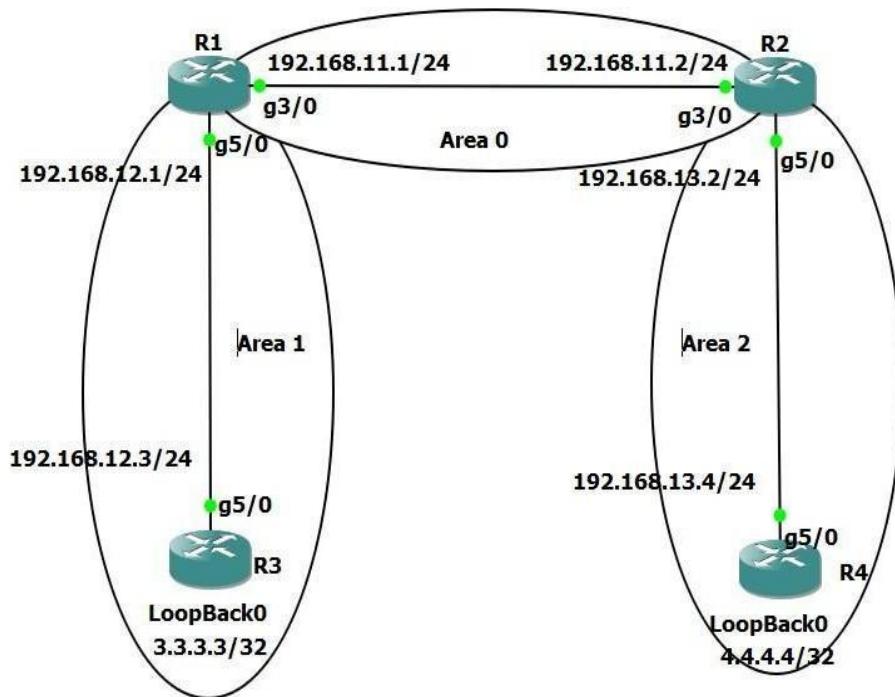
R2#conf t

R2(config)#router ospf 1

R2(config-router)#area 1 virtual-link 1.1.1.1

```
R2(config)#router ospf 1
R2(config-router)#area 1 virtual-link 1.1.1.1
R2(config-router)#
*Mar 1 00:29:56.115: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on OSPF_VL0 from LOADING to FULL, Loading Done
R2(config-router)#

```

Practical 3b - Implement the concept OSPF Standard Area and Backbone**Software Used:**GNS3**Area Step 1:** do topology according to the image given below:**Step 2:** do the initial configuration of the routers R1, R2, R3, R4 as follows:

R1

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int g3/0
R1(config-if)#ip addr 192.168.11.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Feb 19 18:22:04.675: %LINK-3-UPDOWN: Interface GigabitEthernet3/0, changed state to up
*Feb 19 18:22:05.675: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet3/0, changed state to up
R1(config)#int g5/0
R1(config-if)#ip addr 192.168.12.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Feb 19 18:22:27.127: %LINK-3-UPDOWN: Interface GigabitEthernet5/0, changed state to up
*Feb 19 18:22:28.127: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet5/0, changed state to up
```

R2

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int g3/0
R2(config-if)#ip addr 192.168.11.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int g5/
*Feb 19 18:24:09.331: %LINK-3-UPDOWN: Interface GigabitEthernet3/0, changed state to up
*Feb 19 18:24:10.331: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet3/0, changed state to up
R2(config)#int g5/0
R2(config-if)#ip addr 192.168.13.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Feb 19 18:24:31.303: %LINK-3-UPDOWN: Interface GigabitEthernet5/0, changed state to up
*Feb 19 18:24:32.303: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet5/0, changed state to up
```

R3

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int lo0
R3(config-if)#
*Feb 19 18:25:45.519: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip addr 3.3.3.3 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int g5/0
R3(config-if)#ip addr 192.168.12.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Feb 19 18:27:11.867: %LINK-3-UPDOWN: Interface GigabitEthernet5/0, changed state to up
*Feb 19 18:27:12.867: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet5/0, changed state to up
```

R4

```
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#int loop
R4(config)#int loopback 0
R4(config-if)#
*Feb 19 18:27:25.615: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R4(config-if)#ip addr 4.4.4.4 255.255.255.255
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int g5.0
^
% Invalid input detected at '^' marker.

R4(config)#int g5/0
R4(config-if)#ip addr 192.168.13.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#
*Feb 19 18:28:05.667: %LINK-3-UPDOWN: Interface GigabitEthernet5/0, changed state to up
*Feb 19 18:28:06.667: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet5/0, changed state to up ,
```

Step3: Configure the ospf for every router as follows: R1**and R2 for the backbone area:**

```
R1(config)#router ospf 1
R1(config-router)#net
R1(config-router)#network 192.168.11.0 0.0.0.255 area 0
R1(config-router)#exit
R1(config)#
*Feb 19 18:29:50.683: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.13.2 on GigabitEthernet3/0 from LOADING to FULL, Loading Done
R1(config)#router ospf 1
```

R1(config-router)#network 192.168.11.0 0.0.0.255 area 0

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.11.0 0.0.0.255 area 0
R2(config-router)#exit
```

R2(config)#router ospf 1

R2(config-router)#network 192.168.11.0 0.0.0.255 area 0

configure R1 and R3 for area 1:

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.12.0 0.0.0.255 area 1
R1(config-router)#exit
R1(config)#
*Feb 19 18:31:25.571: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on GigabitEthernet5/0 from LOADING to FULL, Loading Done
```

R1(config)#router ospf 1

R1(config-router)#network 192.168.12.0 0.0.0.255 area 1

```
R3(config)#router ospf 1
R3(config-router)#network 3.3.3.3 0.0.0.0 area 1
R3(config-router)#network 192.168.12.0 0.0.0.255 area 1
R3(config-router)#exit
R3(config)#
*Feb 19 18:31:25.479: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.12.1 on GigabitEthernet5/0 from LOADING to FULL, Loading Done
```

R3(config)#router ospf 1

R3(config-router)#network 192.168.12.0 0.0.0.255 area 1

R3(config-router)#network 3.3.3.3 0.0.0.0 area 1

Configure R2 and R4 for area 2:

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.13.0 0.0.0.255 area 2
R2(config-router)#exit
R2(config)#
*Feb 19 18:32:51.447: %OSPF-5-ADJCHG: Process 1, Nbr 4.4.4.4 on GigabitEthernet5/0 from LOADING to FULL, Loading Done
```

R2(config)#router ospf 1

R2(config-router)#network 192.168.13.0 0.0.0.255 area 2

```
R4(config)#router ospf 1
R4(config-router)#net
R4(config-router)#network 192.168.13.0 0.0.0.255 area 2
R4(config-router)#network 4.4.4.4 0.0.0.0 area 2
R4(config-router)#exit
R4(config)#
*Feb 19 18:32:51.791: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.13.2 on GigabitEthernet5/0 from LOADING to FULL, Loading Done
```

R4(config)#router ospf 1

R4(config-router)#network 192.168.13.0 0.0.0.255 area 2

R4(config-router)#network 4.4.4.4 0.0.0.0 area 2

Step 4: Verification of the network

Check the OSPF neighbors:

R1#show ip ospf neighbor

```
R1(config)#do sh ip ospf neighbor
Neighbor ID      Pri   State            Dead Time    Address          Interface
192.168.13.2     1     FULL/DR          00:00:39    192.168.11.2    GigabitEthernet3/0
3.3.3.3          1     FULL/BDR         00:00:32    192.168.12.3    GigabitEthernet5/0
```

R1 has formed a neighbor adjacency with R2 and R3. Let's check R2: R2#show ip ospf neighbor

```
R2(config)#do sh ip ospf neighbor
Neighbor ID      Pri   State            Dead Time    Address          Interface
192.168.12.1     1     FULL/BDR        00:00:35    192.168.11.1    GigabitEthernet3/0
4.4.4.4          1     FULL/DR          00:00:38    192.168.13.4    GigabitEthernet5/0
```

R2 has formed neighbor adjacencies with R1 and R4. The show ip ospf neighbor command, however, doesn't tell me anything about the areas that are used, So we check it using the **show ip ospf neighbor detail command**

R2#show ip ospf neighbor detail

```
R2(config)#do sh ip ospf neighbor detail
Neighbor 192.168.12.1, interface address 192.168.11.1
  In the area 0 via interface GigabitEthernet3/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 192.168.11.2 BDR is 192.168.11.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:39
  Neighbor is up for 00:05:27
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 4.4.4.4, interface address 192.168.13.4
  In the area 2 via interface GigabitEthernet5/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 192.168.13.4 BDR is 192.168.13.2
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:32
  Neighbor is up for 00:01:51
  Index 1/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
```

Above you can see that interface GigabitEthernet0/1 is in area 0 and interface GigabitEthernet0/2 is in area 2. Another good command to find area information is show ip protocols:

R2#show ip protocols

```
R2(config)#do sh ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.13.2
  It is an area border router
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.11.0 0.0.0.255 area 0
    192.168.13.0 0.0.0.255 area 2
  Routing Information Sources:
    Gateway          Distance      Last Update
    4.4.4.4           110          00:02:30
    192.168.12.1     110          00:02:40
    Distance: (default is 110)
```

Above you can see which networks belong to which area:

Network 192.168.11.0 in area 0.

Network 192.168.13.0 in area 2.

Check the routing tables:

R1#show ip route ospf

```
R1(config)#do sh ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

      3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/2] via 192.168.12.3, 00:04:24, GigabitEthernet5/0
        4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/3] via 192.168.11.2, 00:03:01, GigabitEthernet3/0
O IA    192.168.13.0/24 [110/2] via 192.168.11.2, 00:03:01, GigabitEthernet3/0
```

Above we see three OSPF entries. The first one is for 3.3.3.3/32, the loopback interface of R3. It shows up with an O since this is an intra-area route. R1 has also learned about 4.4.4.4/32 and 192.168.24.0/24. These two entries show up as O IA since they are inter-area routes.

R2 has a similar output:

R2#show ip route ospf

```
R2(config)#do sh ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

      3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/3] via 192.168.11.1, 00:03:27, GigabitEthernet3/0
        4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 192.168.13.4, 00:03:17, GigabitEthernet5/0
O IA    192.168.12.0/24 [110/2] via 192.168.11.1, 00:03:27, GigabitEthernet3/0
```

Above we see that R2 has learned about 3.3.3.3/32 and 192.168.13.0/24 which area inter-area routes.

4.4.4.4/32 is an intra-area route. Let's check R3:

R3#show ip route ospf

```
R3(config)#do sh ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

      4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/4] via 192.168.12.1, 00:03:23, GigabitEthernet5/0
O IA    192.168.11.0/24 [110/2] via 192.168.12.1, 00:04:43, GigabitEthernet5/0
O IA    192.168.13.0/24 [110/3] via 192.168.12.1, 00:03:23, GigabitEthernet5/0
```

Everything that R3 has learned is from another area, that's why we only see inter-area routes here. **The same thing applies to R4:**

R4#show ip route ospf

```
R4(config)#do sh ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, 1 - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

      3.0.0.0/32 is subnetted, 1 subnets
o  IA    3.3.3.3 [110/4] via 192.168.13.2, 00:03:27, GigabitEthernet5/0
o  IA  192.168.11.0/24 [110/2] via 192.168.13.2, 00:03:27, GigabitEthernet5/0
o  IA  192.168.12.0/24 [110/3] via 192.168.13.2, 00:03:27, GigabitEthernet5/0
```

Just to be sure, let's try a quick ping between R3 and R4 to prove that our multi-area OSPF configuration is working:

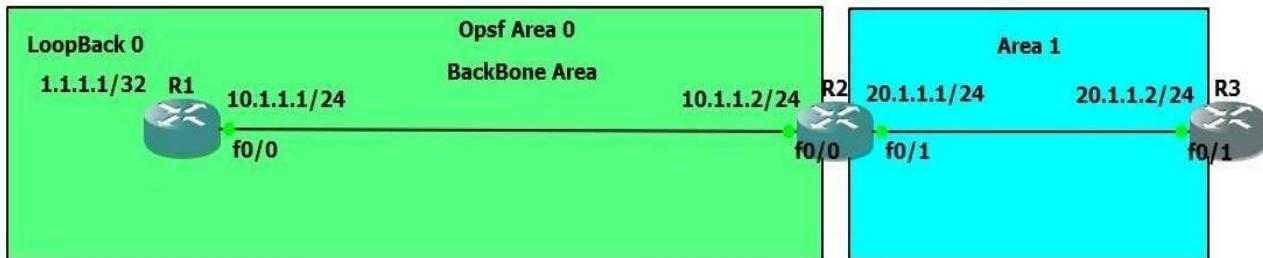
R3#ping 4.4.4.4 source 3.3.3.3

```
R3(config)#do ping 4.4.4.4 source 3.3.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 3.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 88/90/92 ms
```

Practical3c- Implement the concept OSPF Stub and Totally Stubby Area

Software Used:GNS3

Step 1: Create the physical topology



in

GNS3 as shown in the image below :

Step 2: Configure the IPv4 address on the physical interface on the routers :

On R1 :

```
R1(config)#int f0/0
R1(config-if)#ip
R1(config-if)#ip addr
R1(config-if)#ip address 10.1.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
```

R1(config)#interface FastEthernet0/0

R1(config-if)#ip address 10.1.1.1

255.255.255.0 On R2 :

```
R2(config)#int f0/0
R2(config-if)#ip
R2(config-if)#ip addr
R2(config-if)#ip address 10.1.1.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
```

R2(config)#interface FastEthernet0/0

R2(config-if)#ip address 10.1.1.2 255.255.255.0

```
R2(config)#int f0/1
R2(config-if)#ip
R2(config-if)#ip addr
R2(config-if)#ip address 20.1.1.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
```

R2(config-if)#interface FastEthernet1/0

R2(config-if)#ip address 20.1.1.1

255.255.255.0 On R3 :

```
R3(config)#int f0/1
R3(config-if)#ip
R3(config-if)#ip addr
R3(config-if)#ip address 20.1.1.2 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
```

R3(config)#interface FastEthernet1/0

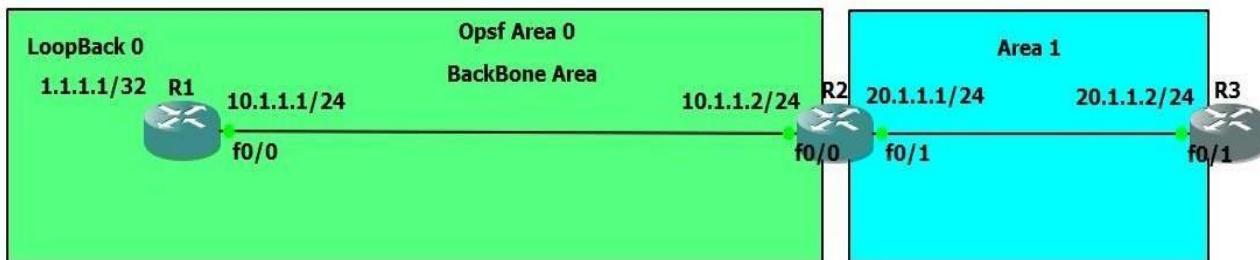
R3(config-if)#ip address 20.1.1.2 255.255.255.0

Step 3: Configure a loopback interface on R1 with an IPv4 address :

R1(config)#interface Loopback0

Practical3c- Implement the concept OSPF Stub and Totally Stubby Area

Step 1: Create the physical topology



GNS3 as shown in the image below :

Step 2: Configure the IPv4 address on the physical interface on the routers :

On R1

```
R1(config)#int f0/0
R1(config-if)#ip
R1(config-if)#ip addr
R1(config-if)#ip address 10.1.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
```

R1(config)#interface FastEthernet0/0

R1(config-if)#ip address 10.1.1.1

255.255.255.0 On R2 :

```
R2(config)#int f0/0
R2(config-if)#ip addr
R2(config-if)#ip address 10.1.1.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
```

R2(config)#interface FastEthernet0/0

R2(config-if)#ip address 10.1.1.2 255.255.255.0

```
R2(config)#int f0/1
R2(config-if)#ip addr
R2(config-if)#ip address 20.1.1.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
```

R2(config-if)#interface FastEthernet1/0

R2(config-if)#ip address 20.1.1.1

255.255.255.0 On R3 :

```
R3(config)#int f0/1
R3(config-if)#ip addr
R3(config-if)#ip address 20.1.1.2 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
```

R3(config)#interface FastEthernet1/0

R3(config-if)#ip address 20.1.1.2 255.255.255.0

Step 3: Configure a loopback interface on R1 with an IPv4 address :

```
R1(config)#interface Loopback0
```

```
R1(config-if)#ip address 1.1.1.1 255.255.255.255
```

```
R1(config)#int lo0
R1(config)#int loopback 0
R1(config-if)#ip addre
*Mar 1 00:00:49.523: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip address 1.1.1.1 255.255.255.255
R1(config-if)#no shut
R1(config-if)#exit
```

Step 4: Configuring the OSPF process on all three routers with the command router OSPF

```
<process-id>
```

```
:
```

```
R1(config)#router ospf 1
```

```
R1(config-if)#exit
```

```
R1(config)#router ospf 1
```

```
R1(config-router)#exit
```

```
R2(config)#router ospf 1
R2(config-router)#exit
```

```
R2(config)#router ospf 1 R2(config-
```

```
router)#exit
```

```
R3(config)#router ospf 1
R3(config-router)#exit
```

```
R3(config)#router ospf 1
```

```
R3(config-router)#exit
```

Step 5: Enabling OSPF on the interfaces with the interface level sub-command IP OSPF

```
<process-id> area <area-id> :
```

```
R1(config)#int loopback 0
R1(config-if)#ip ospf 1 area 0
R1(config-if)#
*Mar 1 00:10:22.455: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R1(config-if)#int f0/0
R1(config-if)#ip ospf 1 area 0
R1(config-if)#no shut
```

```
R1(config)#interface FastEthernet0/0
```

```
R1(config-if)#ip ospf 1 area 0
```

```
R1(config)#interface Loopback0
```

```
R2(config)#int f0/0
R2(config-if)#ip ospf 1 area 0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Mar 1 00:08:32.391: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R2(config)#int f0/1
R2(config-if)#ip ospf 1 area 1
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Mar 1 00:10:49.687: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.2 on FastEthernet0/1 from LOADING to FULL, Loading Done
```

R1(config-if)#ip address 1.1.1.1 255.255.255.255

```
R1(config)#int lo0
R1(config)#int loopback 0
R1(config-if)#ip addre
*Mar 1 00:00:49.523: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip address 1.1.1.1 255.255.255.255
R1(config-if)#no shut
R1(config-if)#exit
```

Step 4: Configuring the OSPF process on all three routers with the command router OSPF <process-id>

:
:

```
R1(config)#router ospf 1
```

```
R1(config-if)#exit
```

R1(config)#router ospf 1

R1(config-router)#exit

```
R2(config)#router ospf 1
R2(config-router)#exit
```

R2(config)#router ospf 1 R2(config-

router)#exit

```
R3(config)#router ospf 1
R3(config-router)#exit
```

R3(config)#router ospf 1

R3(config-router)#exit

Step 5: Enabling OSPF on the interfaces with the interface level sub-command IP OSPF <process-id> area <area-id> :

```
R1(config)#int loopback 0
R1(config-if)#ip ospf 1 area 0
R1(config-if)#
*Mar 1 00:10:22.455: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R1(config-if)#int f0/0
R1(config-if)#ip ospf 1 area 0
R1(config-if)#no shut
R1(config-if)#exit
```

R1(config)#interface FastEthernet0/0

R1(config-if)#ip ospf 1 area 0

R1(config)#interface Loopback0

R1(config-if)#ip ospf 1 area 0

```
R2(config)#int f0/0
R2(config-if)#ip ospf 1 area 0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Mar 1 00:08:32.391: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R2(config)#int f0/1
R2(config-if)#ip ospf 1 area 1
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Mar 1 00:10:49.687: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.2 on FastEthernet0/1 from LOADING to FULL, Loading Done
```

```
R2(config)#interface FastEthernet0/0
```

```
R2(config-if)#ip ospf 1 area 0 R2(config-
if)#interface FastEthernet1/0 R2(config-
if)#ip ospf 1 area 1
```

```
R3(config)#int f0/1
R3(config-if)#ip ospf 1 area 1
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Mar 1 00:10:19.735: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.1 on FastEthernet0/1 from LOADING to FULL, Loading Done
```

```
R3(config)#interface FastEthernet1/0
```

```
R3(config-if)#ip ospf 1 area 1
```

Step 6: Configuring area 2 as a stub area with the router sub-command area <area-id> stub

```
R2(config)#router ospf 1
R2(config-router)#area 1 stub
R2(config-router)#
*Mar 1 00:11:59.735: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.2 on FastEthernet0/1 from FULL to DOWN, Neighbor Down: Adjacency forced to reset
R2(config-router)#exit
R2(config)#
*Mar 1 00:12:30.367: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.2 on FastEthernet0/1 from LOADING to FULL, Loading Done
```

```
R2(config)#router ospf 1
```

```
R2(config-router)#area 1 stub
```

```
R2(config-router)#exit
```

```
R3(config)#router ospf 1
R3(config-router)#area 1 stub
R3(config-router)#
*Mar 1 00:11:59.971: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.1 on FastEthernet0/1 from FULL to DOWN, Neighbor Down: Adjacency forced to reset
*Mar 1 00:12:00.415: %OSPF-5-ADJCHG: Process 1, Nbr 20.1.1.1 on FastEthernet0/1 from LOADING to FULL, Loading Done
```

```
R3(config-router)#exit
```

```
R3(config)#router ospf 1
```

```
R3(config-router)#area 1 stub
```

```
R3(config-router)#exit
```

Step 7: Verifying OSPF configuration on the routers :

```
R1#show ip protocol
```

```
R1(config)#do show ip protocol
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 1.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    Routing on Interfaces Configured Explicitly (Area 0):
      Loopback0
      FastEthernet0/0
      Reference bandwidth unit is 100 mbps
      Routing Information Sources:
        Gateway          Distance      Last Update
        20.1.1.1           110          00:03:11
      Distance: (default is 110)
```

R2#show ip protocol

```
R2(config)#do show ip protocol
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 20.1.1.1
  It is an area border router
  Number of areas in this router is 2. 1 normal 1 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    Routing on Interfaces Configured Explicitly (Area 0):
      FastEthernet0/0
    Routing on Interfaces Configured Explicitly (Area 1):
      FastEthernet0/1
  Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway          Distance      Last Update
    1.1.1.1           110          00:01:07
  Distance: (default is 110)
```

R3#show ip protocol

```
R3(config)#do show ip protocol
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 20.1.1.2
  Number of areas in this router is 1. 0 normal 1 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    Routing on Interfaces Configured Explicitly (Area 1):
      FastEthernet0/1
  Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway          Distance      Last Update
    20.1.1.1          110          00:00:39
  Distance: (default is 110)
```

Step 8: Checking the IPv4 routing table on the routers and seeing OSPF route entry :

R1#show ip route

```
R1(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  1.0.0.0/32 is subnetted, 1 subnets
C     1.1.1.1 is directly connected, Loopback0
  20.0.0.0/24 is subnetted, 1 subnets
O  IA   20.1.1.0 [110/20] via 10.1.1.2, 00:04:21, FastEthernet0/0
    10.0.0.0/24 is subnetted, 1 subnets
C     10.1.1.0 is directly connected, FastEthernet0/0
```

R2#show ip route

```
R2(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

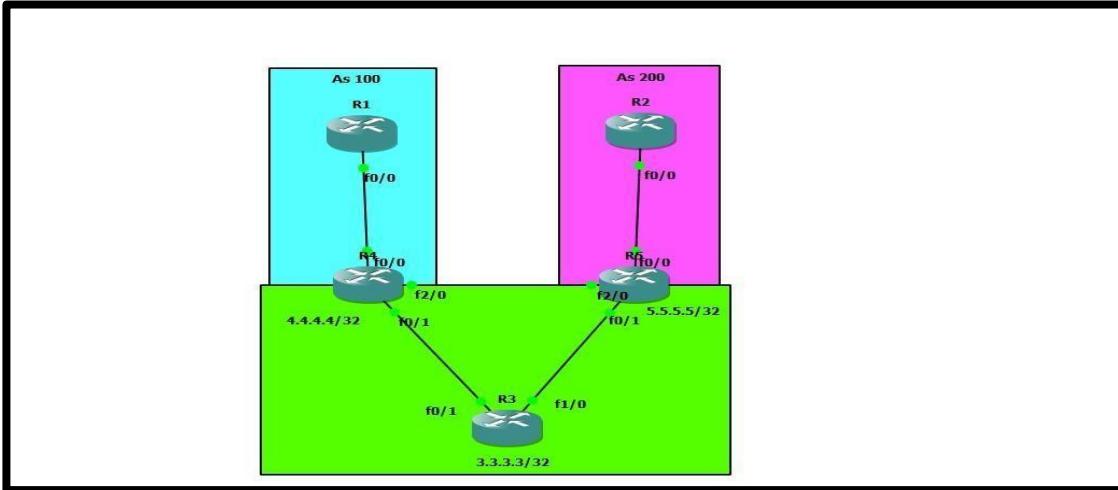
  1.0.0.0/32 is subnetted, 1 subnets
O     1.1.1.1 [110/11] via 10.1.1.1, 00:02:47, FastEthernet0/0
  20.0.0.0/24 is subnetted, 1 subnets
C     20.1.1.0 is directly connected, FastEthernet0/1
    10.0.0.0/24 is subnetted, 1 subnets
C     10.1.1.0 is directly connected, FastEthernet0/0
```

R3#show ip route

```
R3(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is 20.1.1.1 to network 0.0.0.0

  1.0.0.0/32 is subnetted, 1 subnets
O  IA   1.1.1.1 [110/21] via 20.1.1.1, 00:02:18, FastEthernet0/1
    20.0.0.0/24 is subnetted, 1 subnets
C     20.1.1.0 is directly connected, FastEthernet0/1
    10.0.0.0/24 is subnetted, 1 subnets
O  IA   10.1.1.0 [110/20] via 20.1.1.1, 00:02:18, FastEthernet0/1
*IA 0.0.0.0/0 [110/11] via 20.1.1.1, 00:02:18, FastEthernet0/1
```

Practical 4a-Implement the concept of BGP routing protocol**SoftWare Used: GNS3****Ip configuration**

```
R1#conf t  
R1(config)#int fa0/0  
R1(config-if)#ip address 192.168.14.2 255.255.255.0  
R1(config-if)#no shut  
R1(config-if)#ex  
R1(config)#int Loopback11  
R1(config-if)#ip address 11.11.11.11 255.255.255.255  
R1(config-if)#no shut  
R1(config-if)#ex
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int fa0/0
R1(config-if)#ip address 192.168.14.2 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#
*Dec 12 11:33:11.779: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
o up
*Dec 12 11:33:12.779: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#ex
R1(config)#interface Loopback1
R1(config-if)#
*Dec 12 11:34:11.595: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback11, changed state to up
R1(config-if)#ip address 11.11.11.11 255.255.255.255
R1(config-if)#no shutdown
R1(config-if)#ex
R1(config)#end
R1#
```

R2#conf t

R2(config)#int fa0/0

R2(config-if)#ip address 192.168.25.2 255.255.255.0

R2(config-if)#no shut

R2(config-if)#ex

R2(config)#int Loopback22

R2(config-if)#ip address 22.22.22.22 255.255.255.252

R2(config-if)#no shut

R2(config-if)#ex

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int fa0/0
R2(config-if)#ip address 192.168
% Incomplete command.

R2(config-if)#ip address 192.168.25.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#
*Dec 12 11:36:10.003: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Dec 12 11:36:11.003: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#ex
R2(config)#interface Loopback 22
R2(config-if)#ip
*Dec 12 11:36:37.895: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback22, changed state to up
R2(config-if)#ip address 22.22.22.22 255.255.255.252
R2(config-if)#no shutdown
R2(config-if)#ex
R2(config)#end
R2#
*Dec 12 11:59:23.655: %SYS-5-CONFIG_I: Configured from console by console
```

R3#conf t

R3(config)#int fa0/1

R3(config-if)#ip address 192.168.34.3 255.255.255.0

R3(config-if)#no shut

R3(config-if)#ex

R3#conf t

```
R3(config)#int fa1/0
R3(config-if)#ip address 192.168.35.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#int Loopback0
R3(config-if)#ip address 3.3.3.3 255.255.255.255
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#router ospf 1
R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#network 192.168.34.0 0.0.0.255 area 0
R3(config-router)#network 192.168.35.0 0.0.0.255 area 0
R3(config-router)#no shut
R3(config-router)#ex
```

```

initially down
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int fa0/1
R3(config-if)#ip address 192.168.34.3 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#ex
R3(config)#
*Dec 12 11:39:47.211: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Dec 12 11:39:48.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R3(config)#int fa1/0
R3(config-if)#ip address 192.168.35.3 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#ex
R3(config)#
*Dec 12 11:40:37.847: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Dec 12 11:40:38.847: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R3(config)#interface Loopback0
R3(config-if)#
*Dec 12 11:40:56.467: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip address 3
* Incomplete command.

R3(config-if)#ip address 3.3.3.3 255.255.255.255
R3(config-if)#no shutdown
R3(config-if)#ex
R3(config)#router ospf 1
R3(config-router)#netwotk 3.3.3.3 0.0.0.0 area 0
^
* Invalid input detected at '^' marker.

R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#network 192.168.34.0 0.0.0.255 area 0
R3(config-router)#network 192.168.35.0 0.0.0.255 area 0
R3(config-router)#no shutdown
R3(config-router)#ex
R3(config)#
*Dec 12 11:48:53.507: %OSPF-5-ADJCHG: Process 1, Nbr 4.4.4.4 on FastEthernet0/1 from LOADING to FULL, Loading Done
R3(config)#
*Dec 12 11:57:38.343: %OSPF-5-ADJCHG: Process 1, Nbr 5.5.5.5 on FastEthernet1/0 from LOADING to FULL, Loading Done
R3(config)#end
R3#sh

```

R4#conf t

R4(config)#int fa0/0

R4(config-if)#ip address 192.168.14.4 255.255.255.0

R4(config-if)#no shut

R4(config-if)#ex

R4#conf t

R4(config)#int fa2/0

R4(config-if)#ip address 192.168.45.3 255.255.255.0

R4(config-if)#no shut

R4(config-if)#ex

R4(config)#int fa01

R4(config-if)#ip address 192.168.34.4 255.255.255.0

```

R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#int fa0/0
R4(config-if)#ip address 192.168.14.4 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#ex
R4(config)#
*Dec 12 11:45:06.255: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Dec 12 11:45:07.255: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R4(config)#int fa2/0
R4(config-if)#ip address 192.168.45.4 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#ex
R4(config)#
*Dec 12 11:45:51.287: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Dec 12 11:45:52.287: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R4(config)#int fa0/1
R4(config-if)#ip address 192.168.34.4 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#
*Dec 12 11:46:40.515: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Dec 12 11:46:41.515: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R4(config-if)#ex
R4(config)#interface Loopback0
R4(config-if)#
*Dec 12 11:46:57.339: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R4(config-if)#ip address 4.4.4.4 255.255.255.255
R4(config-if)#no shutdown
R4(config-if)#ex
R4(config)#router ospf 1
R4(config-router)#network 4.4.4.0 0
% Incomplete command.

R4(config-router)#network 4.4.4.0 0.0.0.0 area 0
R4(config-router)#network 192.168.34.0 0
% Incomplete command.

R4(config-router)#network 192.168.34.0 0.0.0.255 area 0
R4(config-router)#
*Dec 12 11:48:53.291: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on FastEthernet0/1 from LOADING to FULL, Loading Done
R4(config-router)#network 192.168.45.0 0.0.0.255 area 0
R4(config-router)#no shutdown
R4(config-router)#ex
R4(config)#
*Dec 12 11:58:03.803: %OSPF-5-ADJCHG: Process 1, Nbr 5.5.5.5 on FastEthernet2/0 from LOADING to FULL, Loading Done
R4(config)#end
R4*s
*Dec 12 11:58:44.307: %SYS-5-CONFIG_I: Configured from console by console

```

R5#conf t

R5(config)#int fa0/0

R5(config-if)#ip address 192.168.25.5 255.255.255.0

R5(config-if)#no shut

R5(config-if)#ex

R5#conf t

R5(config)#int fa2/0

R5(config-if)#ip address 192.168.45.5 255.255.255.0

R5(config-if)#no shut

R5(config-if)#ex

R5(config)#int fa0/1

```

R5(config-if)#ip address 192.168.35.5 255.255.255.0
R5(config-if)#no shut
R5(config-if)#ex
R5(config)#int Loopback0
R5(config-if)#ip address 5.5.5.5 255.255.255.255
R5(config-if)#no shut
R5(config-if)#ex
R5(config)#router ospf 1
R5(config-router)#network 5.5.5.5 0.0.0.0 area 0
R5(config-router)#network 192.168.35.0 0.0.0.255 area 0 R5(config-
router)#network 192.168.45.0 0.0.0.255 area 0
R5(config-router)#no shuts
R5(config-router)#ex

```

```

R5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R5(config)#int fa0/0
R5(config-if)#ip address 192.168.25.5 255.255.255.0
R5(config-if)#no shutdown
R5(config-if)#
R5(config-if)#ex
*Dec 12 11:51:29.511: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state t
o up
*Dec 12 11:51:30.511: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R5(config-if)#ex
R5(config)#int fa2/0
R5(config-if)#ip address 192.168.45.5 255.255.255.0
R5(config-if)#no shutdown
R5(config-if)#
^
% Invalid input detected at '^' marker.

R5(config-if)#
*Dec 12 11:52:18.211: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state t
o up
*Dec 12 11:52:19.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R5(config-if)#ex
R5(config)#int fa0/1
R5(config-if)#ip address 192.168.35.5 255.255.255.0
R5(config-if)#no shutdown
R5(config-if)#
*Dec 12 11:53:07.471: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state t
o up
*Dec 12 11:53:08.471: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R5(config-if)#interface Loopback0
R5(config-if)#
*Dec 12 11:53:25.379: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R5(config-if)#
^
% Invalid input detected at '^' marker.

R5(config-if)#ip address 5.5.5.5 255.255.255.255
R5(config-if)#no shutdown
R5(config-if)#
R5(config)#router ospf 1
R5(config-router)#network 5.5.5.5 0.0.0.0 area 0
R5(config-router)#network 192.168.35.0 0.0.0.255 area 0
R5(config-router)#netw
*Dec 12 11:57:38.163: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on FastEthernet0/1
from LOADING to FULL, Loading Done
R5(config-router)#network 192.168.45.0 0.0.0.255 area 0
R5(config-router)#
R5(config)#
*Dec 12 11:58:03.855: %OSPF-5-ADJCHG: Process 1, Nbr 4.4.4.4 on FastEthernet2/0
from LOADING to FULL, Loading Done
R5(config)#
R5#
*Dec 12 11:58:10.755: %SYS-5-CONFIG_I: Configured from console by console

```

Show ip route

R1#show ip route

```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  11.0.0.0/32 is subnetted, 1 subnets
C        11.11.11.11 is directly connected, Loopback11
  192.168.14.0/24 is variably subnetted, 2 subnets, 2 masks
C          192.168.14.0/24 is directly connected, FastEthernet0/0
L          192.168.14.2/32 is directly connected, FastEthernet0/0
R1#conf t
```

R2#show ip route

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        22.22.22.20/30 is directly connected, Loopback22
L        22.22.22.22/32 is directly connected, Loopback22
  192.168.25.0/24 is variably subnetted, 2 subnets, 2 masks
C          192.168.25.0/24 is directly connected, FastEthernet0/0
L          192.168.25.2/32 is directly connected, FastEthernet0/0
R2#
```

R3#show ip route

```
R3#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  3.0.0.0/32 is subnetted, 1 subnets
C        3.3.3.3 is directly connected, Loopback0
  4.0.0.0/32 is subnetted, 1 subnets
O          4.4.4.4 [110/2] via 192.168.34.4, 00:10:13, FastEthernet0/1
  5.0.0.0/32 is subnetted, 1 subnets
O          5.5.5.5 [110/2] via 192.168.35.5, 00:01:28, FastEthernet1/0
  192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C            192.168.34.0/24 is directly connected, FastEthernet0/1
L            192.168.34.3/32 is directly connected, FastEthernet0/1
  192.168.35.0/24 is variably subnetted, 2 subnets, 2 masks
C            192.168.35.0/24 is directly connected, FastEthernet1/0
L            192.168.35.3/32 is directly connected, FastEthernet1/0
O            192.168.45.0/24 [110/2] via 192.168.35.5, 00:00:54, FastEthernet1/0
                           [110/2] via 192.168.34.4, 00:09:43, FastEthernet0/1
R3#
```

R4#show ip route

```
R4#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  3.0.0.0/32 is subnetted, 1 subnets
O   3.3.3.3 [110/2] via 192.168.34.3, 00:09:54, FastEthernet0/1
  4.0.0.0/32 is subnetted, 1 subnets
C   4.4.4.4 is directly connected, Loopback0
  5.0.0.0/32 is subnetted, 1 subnets
O   5.5.5.5 [110/2] via 192.168.45.5, 00:00:44, FastEthernet2/0
  192.168.14.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.14.0/24 is directly connected, FastEthernet0/0
L   192.168.14.4/32 is directly connected, FastEthernet0/0
  192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.34.0/24 is directly connected, FastEthernet0/1
L   192.168.34.4/32 is directly connected, FastEthernet0/1
O   192.168.35.0/24 [110/2] via 192.168.45.5, 00:00:44, FastEthernet2/0
      [110/2] via 192.168.34.3, 00:09:54, FastEthernet0/1
  192.168.45.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.45.0/24 is directly connected, FastEthernet2/0
L   192.168.45.4/32 is directly connected, FastEthernet2/0
R4#
```

R5#show ip route

```
R5#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  3.0.0.0/32 is subnetted, 1 subnets
O   3.3.3.3 [110/2] via 192.168.35.3, 00:00:36, FastEthernet0/1
  4.0.0.0/32 is subnetted, 1 subnets
O   4.4.4.4 [110/2] via 192.168.45.4, 00:00:11, FastEthernet2/0
  5.0.0.0/32 is subnetted, 1 subnets
C   5.5.5.5 is directly connected, Loopback0
  192.168.25.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.25.0/24 is directly connected, FastEthernet0/0
L   192.168.25.5/32 is directly connected, FastEthernet0/0
O   192.168.34.0/24 [110/2] via 192.168.45.4, 00:00:11, FastEthernet2/0
      [110/2] via 192.168.35.3, 00:00:36, FastEthernet0/1
  192.168.35.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.35.0/24 is directly connected, FastEthernet0/1
L   192.168.35.5/32 is directly connected, FastEthernet0/1
  192.168.45.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.45.0/24 is directly connected, FastEthernet2/0
L   192.168.45.5/32 is directly connected, FastEthernet2/0
R5#
```

EBGP Configuration

R1(config)#router bgp 100

R1(config-router)#network 11.11.11.0 mask 255.255.255.255

R1(config-router)#neighbor 192.168.14.4 remote-as 300

R1(config-router)#end

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router bgp 100
R1(config-router)#network 11.11.11.0 mask 255.255.255.255
R1(config-router)#neighbor 192.168.14.4 remote-as 300
R1(config-router)#
*Dec 12 12:08:07.627: %BGP-5-ADJCHANGE: neighbor 192.168.14.4 Up
R1(config-router)#end
R1#sh
*Dec 12 12:29:43.515: %SYS-5-CONFIG_I: Configured from console by console
R1#
```

R2(config)#router bgp 200

R2(config-router)#network 22.22.22.22.0 mask 255.255.255.255

R2(config-router)#neighbor 192.168.25.5 remote-as 300

R2(config-router)#end

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router bgp 200
R2(config-router)#network 22.22.22.0 mask 255.255.255.255
R2(config-router)#neighbor 192.168.25.5 remote-as 300
R2(config-router)#
*Dec 12 12:17:22.675: %BGP-5-ADJCHANGE: neighbor 192.168.25.5 Up
R2(config-router)#end
R2#sh
*Dec 12 12:29:25.035: %SYS-5-CONFIG_I: Configured from console by console
R4(config)#router bgp 300
```

R4(config-router)#neighbor 192.168.14.2 remote-as 100

R4(config-router)#end

```
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#router bgp 300
R4(config-router)#neighbor 192.168.14.2 remote-as 100
R4(config-router)#
*Dec 12 12:08:07.375: %BGP-5-ADJCHANGE: neighbor 192.168.14.2 Up
R4(config-router)#ex
```

R5(config)#router bgp 300

R5(config-router)#neighbor 192.168.25.2 remote-as 200

R5(config-router)#end

```
R5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R5(config)#router bgp 300
R5(config-router)#neighbor 192.168.25.2 remote-as 200
R5(config-router)#ex
```

IBGP Configuration

R3(config)#router bgp 300

R3(config-router)#neighbor 4.4.4.4 remote-as 300

R3(config-router)#neighbor 4.4.4.4 update-source Loopback0

R3(config-router)#neighbor 5.5.5.5 remote-as 300

R3(config-router)#neighbor 5.5.5.5 update-source Loopback0

R3(config-router)#end

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router bgp 300
R3(config-router)#neighbor 4.4.4.4 remote-as 300
R3(config-router)#neighbor 4.4.4.4 upa
*Dec 12 12:20:52.767: %BGP-5-ADJCHANGE: neighbor 4.4.4.4 Up
R3(config-router)#neighbor 4.4.4.4 update-source Loopback0
R3(config-router)#neighbor 5.5.5.5 remote-as 300
R3(config-router)#neighbor 5.5.5.5 up
*Dec 12 12:21:46.975: %BGP-5-ADJCHANGE: neighbor 5.5.5.5 Up
R3(config-router)#neighbor 5.5.5.5 update-source Loopback0
R3(config-router)#end
R4(config)#router bgp 300
```

R4(config-router)#neighbor 3.3.3.3 remote-as 300

R4(config-router)#neighbor 3.3.3.3 update-source Loopback0

R4(config-router)#neighbor 5.5.5.5 remote-as 300

R4(config-router)#neighbor 5.5.5.5 update-source Loopback0

R4(config-router)#end

```
R4(config)#router bgp 300
R4(config-router)#neighbor 3.3.3.3 remote-as 300
R4(config-router)#neighbor 3.3.3.3 update-source Loopback0
R4(config-router)#neighbor 5.5.5.5 remote-as 300
R4(config-router)#neighbor 5.5.5.5 update-source Loopback0
R4(config-router)#
*Dec 12 12:18:34.223: %BGP-5-ADJCHANGE: neighbor 5.5.5.5 Up
R4(config-router)#
*Dec 12 12:20:52.471: %BGP-5-ADJCHANGE: neighbor 3.3.3.3 Up
R4(config-router)#end
R4(config)#router bgp 300
```

R4(config-router)#neighbor 4.4.4.4 remote-as 300

R4(config-router)#neighbor 4.4.4.4 update-source Loopback0

R4(config-router)#neighbor 3.3.3.3 remote-as 300

R4(config-router)#neighbor 3.3.3.3 update-source Loopback0

R4(config-router)#end

```
R5(config)#router bgp 300
R5(config-router)#neighbor 4.4.4.4 remote-as 300
R5(config-router)#neighbor 4.4.4.4
*Dec 12 12:18:34.287: %BGP-5-ADJCHANGE: neighbor 4.4.4.4 Up
R5(config-router)#neighbor 4.4.4.4 update-source Loopback0
R5(config-router)#neighbor 3.3.3.3 remote-as 300
R5(config-router)#neighbor 3.3.3.3 update-source Loopback0
R5(config-router)#
*Dec 12 12:21:46.739: %BGP-5-ADJCHANGE: neighbor 3.3.3.3 Up
R5(config-router)#end
R5#
```

Show BGP Neighbor

R1#show bgp neighbor

```
R1#show bgp neighbor
BGP neighbor is 192.168.14.4, remote AS 300, external link
BGP version 4, remote router ID 4.4.4.4
BGP state = Established, up for 00:21:45
Last read 00:00:29, last write 00:00:15, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets ASN Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
    Stateful switchover support enabled: NO for session 1
Message statistics:
  InQ depth is 0
  OutQ depth is 0
      Sent      Rcvd
  Opens:        1        1
  Notifications: 0        0
  Updates:       1        1
  Keepalives:    26       25
  Route Refresh: 0        0
  Total:         28       27
Default minimum time between advertisement runs is 30 seconds
```

R2#show bgp neighbor

```
R2#show bgp neighbor
BGP neighbor is 192.168.25.5, remote AS 300, external link
BGP version 4, remote router ID 5.5.5.5
BGP state = Established, up for 00:12:09
Last read 00:00:32, last write 00:00:22, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets ASN Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
    Stateful switchover support enabled: NO for session 1
Message statistics:
  InQ depth is 0
  OutQ depth is 0
      Sent      Rcvd
  Opens:        1        1
  Notifications: 0        0
  Updates:       1        1
  Keepalives:    15       15
  Route Refresh: 0        0
  Total:         17       17
Default minimum time between advertisement runs is 30 seconds
```

R3#show bgp neighbor

```
R3#show bgp neighbor
BGP neighbor is 4.4.4.4, remote AS 300, internal link
BGP version 4, remote router ID 4.4.4.4
BGP state = Established, up for 00:08:20
Last read 00:00:12, last write 00:00:30, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets ASN Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
    Stateful switchover support enabled: NO for session 1
Message statistics:
  InQ depth is 0
  OutQ depth is 0
      Sent      Rcvd
  Opens:        1        1
  Notifications: 0        0
  Updates:       1        0
  Keepalives:    11       10
  Route Refresh: 0        0
  Total:         13       11
Default minimum time between advertisement runs is 0 seconds
```

R4#show bgp neighbor

```

R4#show bgp neighbor
BGP neighbor is 3.3.3.3, remote AS 300, internal link
  BGP version 4, remote router ID 3.3.3.3
  BGP state = Established, up for 00:07:59
  Last read 00:00:09, last write 00:00:41, hold time is 180, keepalive interval is 60 seconds
  Neighbor sessions:
    1 active, is not multisession capable (disabled)
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Four-octets ASN Capability: advertised and received
    Address family IPv4 Unicast: advertised and received
    Enhanced Refresh Capability: advertised and received
    Multisession Capability:
      Stateful switchover support enabled: NO for session 1
  Message statistics:
    InQ depth is 0
    OutQ depth is 0

          Sent      Rcvd
  Opens:          1          1
  Notifications: 0          0
  Updates:        0          1
  Keepalives:     9         11
  Route Refresh: 0          0
  Total:         10         13
Default minimum time between advertisement runs is 0 seconds

```

R5#show bgp neighbor

```

R5#show bgp neighbors
BGP neighbor is 3.3.3.3, remote AS 300, internal link
  BGP version 4, remote router ID 3.3.3.3
  BGP state = Established, up for 00:05:55
  Last read 00:00:22, last write 00:00:43, hold time is 180, keepalive interval is 60 seconds
  Neighbor sessions:
    1 active, is not multisession capable (disabled)
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Four-octets ASN Capability: advertised and received
    Address family IPv4 Unicast: advertised and received
    Enhanced Refresh Capability: advertised and received
    Multisession Capability:
      Stateful switchover support enabled: NO for session 1
  Message statistics:
    InQ depth is 0
    OutQ depth is 0

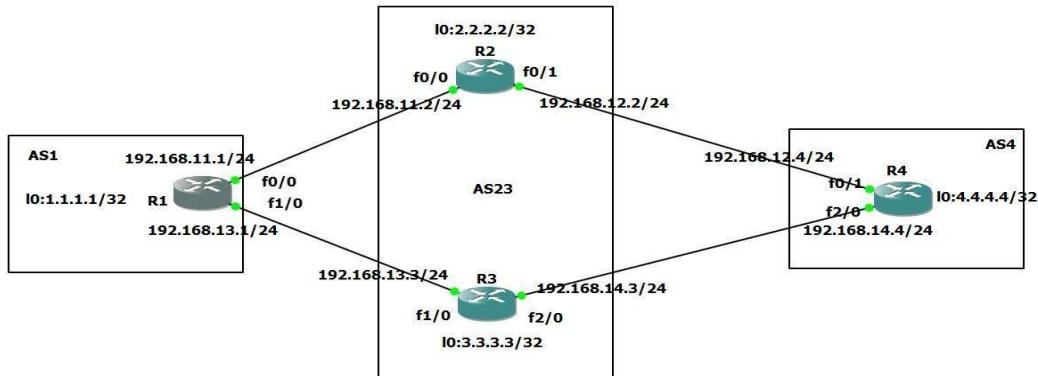
          Sent      Rcvd
  Opens:          1          1
  Notifications: 0          0
  Updates:        0          0
  Keepalives:     7          7
  Route Refresh: 0          0
  Total:         8          8
Default minimum time between advertisement runs is 0 seconds

```

Practical 4b- Implement the concept of BGP Path Attributes – MED

Software Used:GNS3

Step 1: do the topology as below image



Step 2: do the necessary router configuration for R1, R2, R3, R4 as follows R1

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#
R1(config)#int loop
R1(config)#int loopback 0
R1(config-if)#ip addr
*Mar 1 00:00:28.719: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip add 1.1.1.1 255.255.255.255
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int f 0/0
R1(config-if)#ip add 192.168.11.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
% Invalid input detected at '^' marker.

R1(config-if)#exit
*Mar 1 00:01:07.723: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:08.723: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#exit
R1(config)#int f1/0
R1(config-if)#ip add 192.168.13.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Mar 1 00:01:27.375: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Mar 1 00:01:28.375: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
```

R2

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#
R2(config)#int loop
R2(config)#int loopback 0
R2(config-if)#ip addr 22
*Mar 1 00:00:51.027: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip add 2.2.2.2 255.255.255.255
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int f0/0
R2(config-if)#ip add 192.168.11.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Mar 1 00:01:17.795: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:18.795: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#int f0/1
R2(config-if)#ip add 192.168.12.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Mar 1 00:01:38.191: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:01:39.191: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
```

R3

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int lo0
R3(config)#int loopback 0
R3(config-if)#ip
*Mar 1 00:01:20.499: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip addr 3.3.3.3 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f1/0
R3(config-if)#ip addr 192.168.13.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int
*Mar 1 00:02:15.043: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Mar 1 00:02:16.043: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R3(config-if)#int f2/0
R3(config-if)#ip addr 192.168.14.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Mar 1 00:02:40.827: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Mar 1 00:02:41.827: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
```

R4

```
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#int loop
R4(config)#int loopback 0
R4(config-if)#ip
*Mar 1 00:02:02.331: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R4(config-if)#ip addr 4.4.4.4 255.255.255.0
R4(config-if)#ip addr 4.4.4.4 255.255.255.255
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#
% Invalid input detected at '^' marker.

R4(config-if)#exit
R4(config)#int f0/1
R4(config-if)#ip addr 192.168.12.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#
*Mar 1 00:02:40.959: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:02:41.959: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R4(config)#int f2/0
R4(config-if)#ip addr 192.168.14.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#
*Mar 1 00:03:00.167: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Mar 1 00:03:01.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
```

R1 Interface Configuration:

R1(config)#do show ip int brief

FastEthernet0/0	192.168.11.1	YES manual	up	up
Serial0/0	unassigned	YES unset	administratively down	down
FastEthernet0/1	unassigned	YES unset	administratively down	down
Serial0/1	unassigned	YES unset	administratively down	down
Serial0/2	unassigned	YES unset	administratively down	down
Serial0/3	unassigned	YES unset	administratively down	down
FastEthernet1/0	192.168.13.1	YES manual	up	up

Loopback0	1.1.1.1	YES manual	up	up
-----------	---------	------------	----	----

R2 Interface Configuration:

R2(config)#do show ip int brief

FastEthernet0/0	192.168.11.2	YES manual	up	up
Serial0/0	unassigned	YES unset	administratively down	down
FastEthernet0/1	192.168.12.2	YES manual	up	up
Serial0/1	unassigned	YES unset	up	down
Loopback0	2.2.2.2	YES manual	up	up

R3 Interface Configuration:

R3(config)#do show ip int br

FastEthernet1/0	192.168.13.3	YES manual	up	up
FastEthernet2/0	192.168.14.3	YES manual	up	up
Serial1	unassigned	YES unset	up	down
Loopback0	3.3.3.3	YES manual	up	up

R4 Interface Configuration:

R4(config)#do show ip int brief

```
R4(config)#do sh ip int brief
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    unassigned     YES unset administratively down down
Serial0/0          unassigned     YES unset administratively down down
FastEthernet0/1    192.168.12.4   YES manual up           up
Loopback0          4.4.4.4       YES manual up           up
```

Step 3: configure BGP in all the routers

R1 BGP Configuration:

```
R1(config)#router bgp 1
R1(config-router)#neigh
R1(config-router)#neighbor 192.168.11.2 remote
R1(config-router)#neighbor 192.168.11.2 remote-as 23
R1(config-router)#neighbor 192.168.13.3 remote-as 23
R1(config-router)#redistribute con
R1(config-router)#redistribute connected
R1(config-router)#exit
R1(config)#
*Mar 1 00:08:56.491: %BGP-5-ADJCHANGE: neighbor 192.168.13.3 Up
R1(config)#
*Mar 1 00:09:35.735: %BGP-5-ADJCHANGE: neighbor 192.168.11.2 Up
```

R2 BGP Configuration:

```
R2(config)#router bgp 23
R2(config-router)#neigh
R2(config-router)#neighbor 192.168.11.1 remote
R2(config-router)#neighbor 192.168.11.1 remote-as 1
R2(config-router)#neighbor 192.168.12.4 remote-as 4
R2(config-router)#redist
R2(config-router)#redistribute
*Mar 1 00:08:23.867: %BGP-5-ADJCHANGE: neighbor 192.168.12.4 Up
R2(config-router)#redistribute conn
R2(config-router)#redistribute connected
R2(config-router)#exit
R2(config)#
*Mar 1 00:08:41.679: %BGP-5-ADJCHANGE: neighbor 192.168.11.1 Up
```

R3 BGP Configuration:

```
R3(config)#router bgp 23
R3(config-router)#reigh
R3(config-router)#neigh
R3(config-router)#neighbor 192.168.13.1 remote
R3(config-router)#neighbor 192.168.13.1 remote-as 1
R3(config-router)#neighbor 192.168.14.4 remote-as 4
R3(config-router)#redis
R3(config-router)#redistribute con
R3(config-router)#redistribute connected
R3(config-router)#exit
R3(config)#
*Mar 1 00:07:17.979: %BGP-5-ADJCHANGE: neighbor 192.168.13.1 Up
*Mar 1 00:07:18.603: %BGP-5-ADJCHANGE: neighbor 192.168.14.4 Up
```

R4 BGP Configuration:

```
R4(config)#router bgp 4
R4(config-router)#neight
R4(config-router)#neigh
R4(config-router)#neighbor 192.168.12.2 remot
R4(config-router)#neighbor 192.168.12.2 remote-as 23
R4(config-router)#neighbor 192.168.14.3 remote-as 23
R4(config-router)#redis
R4(config-router)#redistribute conn
R4(config-router)#redistribute connected
R4(config-router)#exit
R4(config)#
*Mar 1 00:06:44.807: %BGP-5-ADJCHANGE: neighbor 192.168.14.3 Up
R4(config)#
*Mar 1 00:07:05.615: %BGP-5-ADJCHANGE: neighbor 192.168.12.2 Up
```

From the below R1 BGP table, we can see that the R1 prefers the path through R3 (Next Hop IP as 192.168.13.3) to reach the Network 4.4.4.4/32.

Symbol ">" in-front of the network indicates the best path (router prefers to use this path to send the traffic)

```
R1(config)#do sh ip bgp
BGP table version is 10, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

      Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32      0.0.0.0              0       32768 ? 
*> 2.2.2.2/32      192.168.11.2        0       0 23 ? 
*> 3.3.3.3/32      192.168.13.3        0       0 23 ? 
*  4.4.4.4/32      192.168.11.2        0       0 23 4 ? 
*> 
*  192.168.11.0    192.168.11.2        0       0 23 ? 
*> 
*> 0.0.0.0          0.0.0.0              0       32768 ? 
*> 192.168.12.0    192.168.11.2        0       0 23 ? 
*  192.168.13.0    192.168.13.3        0       0 23 ? 
*  192.168.13.0    192.168.13.3        0       0 23 ? 
*> 
*  0.0.0.0          0.0.0.0              0       32768 ? 
*> 192.168.14.0    192.168.11.2        0       0 23 4 ? 
*> 
192.168.13.3      0
```

Now, our task to change the path through R2 to reach the Network 4.4.4.4/32.

Step4: Create route-map MED-TEST

Here, I have created a route-map named as MED-TEST. Next, I have used the command "match ip address 1" to match the access-list 1, and then if it matches I have set the Metric (MED) value as 500. I have created a second permit statement for the same route-map AS-PATH-TEST.

Creating a Route-Map:

```
R3(config)#route-map MED-TEST permit
R3(config-route-map)#match ip address 1
R3(config-route-map)#set m
R3(config-route-map)#set met
R3(config-route-map)#set metric 500
R3(config-route-map)#exit
R3(config)#route-m
R3(config)#route-map MED-
R3(config)#route-map MED-TEST permit 20
R3(config-route-map)#exit
R3(config)#do sh route-map
route-map MED-TEST, permit, sequence 10
  Match clauses:
    ip address (access-lists): 1
  Set clauses:
    metric 500
  Policy routing matches: 0 packets, 0 bytes
route-map MED-TEST, permit, sequence 20
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
R3(config)#acc
R3(config)#access-list 1 permit host 4.4.4.4
R3(config)#exit
```

R3#conf terminal

Enter configuration commands, one per line. End with CNTL/Z. R3(config)#

R3(config)#route-map MED-TEST permit

R3(config-route-map)#match ip address 1

R3(config-route-map)#set metric 500

R3(config-route-map)#exi

```
R3(config)#route-map MED-TEST permit 20
R3(config-route-map)#end
R3#
```

You can also view the created c-map using the below command:

```
R3#show route-map
```

```
R3(config)#do sh route-map
route-map MED-TEST, permit, sequence 10
  Match clauses:
    ip address (access-lists): 1
  Set clauses:
    metric 500
  Policy routing matches: 0 packets, 0 bytes
route-map MED-TEST, permit, sequence 20
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
```

Next create a access-list as below:

```
R3(config)#access-list 1 permit host 4.4.4.4
R3(config)#exit
```

You can view configured access-list using the below command, R3#show

access-lists

```
R3#sh access-lists
Standard IP access list 1
  10 permit 4.4.4.4
```

Applying the created route-map to bgp configuration.

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router bgp 23
R3(config-router)#neighbor
R3(config-router)#neighbor 192.168.13.1 route-map MED-TEST out
R3(config-router)#exit
R3(config)#[
```

Here, we have mapped the route-map MED-TEST as "OUT" to the neighbor R1 (192.168.13.1). so that it will advertise the configured Metric value (value: 500) its neighbor.

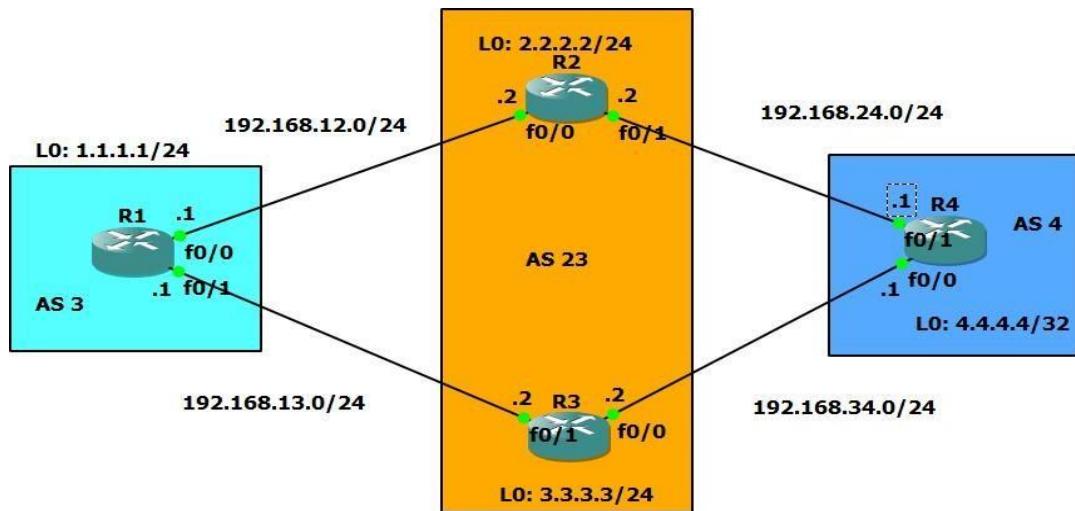
You need to clear the BGP session to take the newly applied configuration to take effect. In-

order to clear the bgp session, use the command "clear ip bgp * soft in"

```
R1(config)#do clear ip bgp * soft in
R1(config)#do sh ip bgp
BGP table version is 11, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.0/32      0.0.0.0             0       32768 ?>
*> 2.2.2.0/32      192.168.11.2        0       0 23 ?>
*> 3.3.3.0/32      192.168.13.3        0       0 23 ?>
*> 4.4.4.0/32      192.168.11.2        0       0 23 4 ?>
*   192.168.11.0    192.168.13.3        500     0 23 4 ?>
*> 0.0.0.0          0.0.0.0             0       32768 ?>
*> 192.168.12.0    192.168.11.2        0       0 23 ?>
*   192.168.13.0    192.168.13.3        0       0 23 ?>
*> 0.0.0.0          0.0.0.0             0       32768 ?>
*> 192.168.14.0    192.168.11.2        0       0 23 ?>
*> 192.168.13.0    192.168.13.3        0       0 23 ?>
R1(config)#[
```

Practical 4c-Implement the concept of BGP AS Path Attribute

SoftWare Used: GNS3



Ip configuration

R1 Interface Information:

```
R1#conf t
R1(config)#int fa0/0
R1(config-if)#ip address 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1#conf t
R1(config)#int fa0/1
R1(config-if)#ip address 192.168.13.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int Loopback0
R1(config-if)#ip address 1.1.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int fa0/0
R1(config-if)#ip address 192.168.2.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#ex
R1(config)#
*Dec 13 15:06:06.227: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
o up
*Dec 13 15:06:07.227: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet
0/0, changed state to up
R1(config)#int fa0/1
R1(config-if)#ip address 192.168.13.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#ex
R1(config)#
*Dec 13 15:06:56.863: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to
o up
*Dec 13 15:06:57.863: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet
0/1, changed state to up
R1(config)#interface Loopback0
R1(config-if)#
*Dec 13 15:07:19.075: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
changed state to up
R1(config-if)#ip address 1.1.1.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#end
```

R2 Interface Information:

```
R2#conf t
R2(config)#int fa0/0
R2(config-if)#ip address 192.168.12.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2#conf t
R2(config)#int fa0/1
R2(config-if)#ip address 192.168.24.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int Loopback0
R2(config-if)#ip address 2.2.2.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
```

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int fa0/0
R2(config-if)#ip address 192.168.12.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#ex
R2(config)#
*Dec 13 15:12:00.823: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Dec 13 15:12:01.823: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#int fa0/1
R2(config-if)#ip address 192.168.24.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#ex
R2(config)#
*Dec 13 15:12:39.803: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Dec 13 15:12:40.803: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config)#interface Loopback0
R2(config-if)#i
*Dec 13 15:12:52.755: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip address 2.2.2.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#ex
R2(config)#end

```

R3 Interface Information:

```

R3#conf t
R3(config)#int fa0/0
R3(config-if)#ip address 192.168.13.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
R3#conf t
R3(config)#int fa0/1
R3(config-if)#ip address 192.168.34.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#int Loopback0
R3(config-if)#ip address 3.3.3.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex

```

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int fa0/0
R3(config-if)#ip address 192.168.13.3 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#ex
R3(config)#int
*Dec 13 15:15:33.255: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Dec 13 15:15:34.255: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#int fa0/1
R3(config-if)#ip address 192.168.34.3 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#ex
R3(config)#
*Dec 13 15:16:10.931: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Dec 13 15:16:11.931: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R3(config)#interface Loopback0
R3(config-if)#ip address 3.3.3.3 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#ex
R3(config)#end
```

R4 Interface Information:

R4#conf t

R4(config)#int fa0/0

R4(config-if)#ip address 192.168.24.4 255.255.255.0

R4(config-if)#no shut

R4(config-if)#ex

R4#conf t

R4(config)#int fa0/1

R4(config-if)#ip address 192.168.34.4 255.255.255.0

R4(config-if)#no shut

R4(config-if)#ex

R4(config)#int Loopback0

R4(config-if)#ip address 4.4.4.4 255.255.255.252

R4(config-if)#no shut

R4(config-if)#ex

Show ip route

R1#show ip route

```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  1.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C     1.1.1.0/24 is directly connected, Loopback0
L     1.1.1.1/32 is directly connected, Loopback0
  192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.2.0/24 is directly connected, FastEthernet0/0
L     192.168.2.1/32 is directly connected, FastEthernet0/0
  192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.13.0/24 is directly connected, FastEthernet0/1
L     192.168.13.1/32 is directly connected, FastEthernet0/1

```

R2#show ip route

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  2.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C     2.2.2.0/24 is directly connected, Loopback0
L     2.2.2.2/32 is directly connected, Loopback0
  192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.12.0/24 is directly connected, FastEthernet0/0
L     192.168.12.2/32 is directly connected, FastEthernet0/0
  192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.24.0/24 is directly connected, FastEthernet0/1
L     192.168.24.2/32 is directly connected, FastEthernet0/1

```

R3#show ip route

```
R3#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  3.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C     3.3.3.0/24 is directly connected, Loopback0
L     3.3.3.3/32 is directly connected, Loopback0
  192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.13.0/24 is directly connected, FastEthernet0/0
L     192.168.13.3/32 is directly connected, FastEthernet0/0
  192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.34.0/24 is directly connected, FastEthernet0/1
L     192.168.34.3/32 is directly connected, FastEthernet0/1

```

R4#show ip route

```
R4#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

  192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.24.0/24 is directly connected, FastEthernet0/0
L     192.168.24.4/32 is directly connected, FastEthernet0/0
  192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.34.0/24 is directly connected, FastEthernet0/1
L     192.168.34.4/32 is directly connected, FastEthernet0/1

```

Show ip int brief R1#show

ip int brief

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.2.1	YES	manual	up	up
FastEthernet0/1	192.168.13.1	YES	manual	up	up
FastEthernet1/0	unassigned	YES	unset	administratively down	down
FastEthernet2/0	unassigned	YES	unset	administratively down	down
FastEthernet2/1	unassigned	YES	unset	administratively down	down
Serial4/0	unassigned	YES	unset	administratively down	down
Serial4/1	unassigned	YES	unset	administratively down	down
Serial4/2	unassigned	YES	unset	administratively down	down
Serial4/3	unassigned	YES	unset	administratively down	down
Serial4/4	unassigned	YES	unset	administratively down	down
Serial4/5	unassigned	YES	unset	administratively down	down
Serial4/6	unassigned	YES	unset	administratively down	down
Serial4/7	unassigned	YES	unset	administratively down	down
Serial5/0	unassigned	YES	unset	administratively down	down
Serial5/1	unassigned	YES	unset	administratively down	down
Serial5/2	unassigned	YES	unset	administratively down	down
Serial5/3	unassigned	YES	unset	administratively down	down
Ethernet6/0	unassigned	YES	unset	administratively down	down
Ethernet6/1	unassigned	YES	unset	administratively down	down
Ethernet6/2	unassigned	YES	unset	administratively down	down
Ethernet6/3	unassigned	YES	unset	administratively down	down
Ethernet6/4	unassigned	YES	unset	administratively down	down
Ethernet6/5	unassigned	YES	unset	administratively down	down
Ethernet6/6	unassigned	YES	unset	administratively down	down
Ethernet6/7	unassigned	YES	unset	administratively down	down
Loopback0	1.1.1.1	YES	manual	up	up

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.12.2	YES	manual	up	up
FastEthernet0/1	192.168.24.2	YES	manual	up	up
FastEthernet1/0	unassigned	YES	unset	administratively down	down
FastEthernet2/0	unassigned	YES	unset	administratively down	down
FastEthernet2/1	unassigned	YES	unset	administratively down	down
Serial4/0	unassigned	YES	unset	administratively down	down
Serial4/1	unassigned	YES	unset	administratively down	down
Serial4/2	unassigned	YES	unset	administratively down	down
Serial4/3	unassigned	YES	unset	administratively down	down
Serial4/4	unassigned	YES	unset	administratively down	down
Serial4/5	unassigned	YES	unset	administratively down	down
Serial4/6	unassigned	YES	unset	administratively down	down
Serial4/7	unassigned	YES	unset	administratively down	down
Serial5/0	unassigned	YES	unset	administratively down	down
Serial5/1	unassigned	YES	unset	administratively down	down
Serial5/2	unassigned	YES	unset	administratively down	down
Serial5/3	unassigned	YES	unset	administratively down	down
Ethernet6/0	unassigned	YES	unset	administratively down	down
Ethernet6/1	unassigned	YES	unset	administratively down	down
Ethernet6/2	unassigned	YES	unset	administratively down	down
Ethernet6/3	unassigned	YES	unset	administratively down	down
Ethernet6/4	unassigned	YES	unset	administratively down	down
Ethernet6/5	unassigned	YES	unset	administratively down	down
Ethernet6/6	unassigned	YES	unset	administratively down	down
Ethernet6/7	unassigned	YES	unset	administratively down	down
Loopback0	2.2.2.2	YES	manual	up	up

R3#show ip int brief

```
R3#show ip int brief
Interface          IP-Address      OK? Method Status           Protocol
FastEthernet0/0    192.168.13.3   YES manual up            up
FastEthernet0/1    192.168.34.3   YES manual up            up
FastEthernet1/0    unassigned     YES unset administratively down down
FastEthernet2/0    unassigned     YES unset administratively down down
FastEthernet2/1    unassigned     YES unset administratively down down
Serial4/0          unassigned     YES unset administratively down down
Serial4/1          unassigned     YES unset administratively down down
Serial4/2          unassigned     YES unset administratively down down
Serial4/3          unassigned     YES unset administratively down down
Serial4/4          unassigned     YES unset administratively down down
Serial4/5          unassigned     YES unset administratively down down
Serial4/6          unassigned     YES unset administratively down down
Serial4/7          unassigned     YES unset administratively down down
Serial5/0          unassigned     YES unset administratively down down
Serial5/1          unassigned     YES unset administratively down down
Serial5/2          unassigned     YES unset administratively down down
Serial5/3          unassigned     YES unset administratively down down
Ethernet6/0        unassigned     YES unset administratively down down
Ethernet6/1        unassigned     YES unset administratively down down
Ethernet6/2        unassigned     YES unset administratively down down
Ethernet6/3        unassigned     YES unset administratively down down
Ethernet6/4        unassigned     YES unset administratively down down
Ethernet6/5        unassigned     YES unset administratively down down
Ethernet6/6        unassigned     YES unset administratively down down
Ethernet6/7        unassigned     YES unset administratively down down
Loopback0          3.3.3.3       YES manual up            up
```

R4#show ip int brief

```
R4#show ip int brief
Interface          IP-Address      OK? Method Status           Protocol
FastEthernet0/0    192.168.24.4  YES manual up            up
FastEthernet0/1    192.168.34.4  YES manual up            up
FastEthernet1/0    unassigned     YES unset administratively down down
FastEthernet2/0    unassigned     YES unset administratively down down
FastEthernet2/1    unassigned     YES unset administratively down down
Serial4/0          unassigned     YES unset administratively down down
Serial4/1          unassigned     YES unset administratively down down
Serial4/2          unassigned     YES unset administratively down down
Serial4/3          unassigned     YES unset administratively down down
Serial4/4          unassigned     YES unset administratively down down
Serial4/5          unassigned     YES unset administratively down down
Serial4/6          unassigned     YES unset administratively down down
Serial4/7          unassigned     YES unset administratively down down
Serial5/0          unassigned     YES unset administratively down down
Serial5/1          unassigned     YES unset administratively down down
Serial5/2          unassigned     YES unset administratively down down
Serial5/3          unassigned     YES unset administratively down down
Ethernet6/0        unassigned     YES unset administratively down down
Ethernet6/1        unassigned     YES unset administratively down down
Ethernet6/2        unassigned     YES unset administratively down down
Ethernet6/3        unassigned     YES unset administratively down down
Ethernet6/4        unassigned     YES unset administratively down down
Ethernet6/5        unassigned     YES unset administratively down down
Ethernet6/6        unassigned     YES unset administratively down down
Ethernet6/7        unassigned     YES unset administratively down down
Loopback0          unassigned     YES unset up             up
```

BGP Configuration

R1(config)#router bgp 1

R1(config-router)#neighbor 192.168.12.2 remote-as 23

R1(config-router)#neighbor 192.168.13.3 remote-as 23

R1(config-router)#redistribute connected

R1(config-router)#end

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router bgp 1
R1(config-router)#neighbor 192.168.12
% Incomplete command.

R1(config-router)#neighbor 192.168.12.2 remote-as 23
R1(config-router)#neighbor 192.168.13.3 remote-as 23
R1(config-router)#redistribute connected
R1(config-router)#end
R1#
*Dec 13 15:23:10.283: %SYS-5-CONFIG_I: Configured from console by console
```

R2(config)#router bgp 23

R2(config-router)#neighbor 192.168.2.1 remote-as 1

R2(config-router)#neighbor 192.168.34.4 remote-as 4

R2(config-router)#redistribute connected

R2(config-router)#end

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router bgp 23
R2(config-router)#neighbor 192.168.2.1 remote-as 1
R2(config-router)#neighbor 192.168.24.4 remote-as 4
R2(config-router)#redistribute connected
R2(config-router)#end
--
```

R3(config)#router bgp 23

R3(config-router)#neighbor 192.168.13.1 remote-as 1

R3(config-router)#neighbor 192.168.34.4 remote-as 4

R3(config-router)#redistribute connected

R3(config-router)#end

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router bgp 23
R3(config-router)#neighbor 192.168.13.1 remote-as 1
R3(config-router)#neighbor 192.168.34.4 remote-as 4
R3(config-router)#redistribute connected
R3(config-router)#end
R3#
```

R4(config)#router bgp 4

R4(config-router)#neighbor 192.168.24.2 remote-as 23

R4(config-router)#neighbor 192.168.34.3 remote-as 23

R4(config-router)#redistribute connected

R4(config-router)#end

```
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#router bgp 4
R4(config-router)#neighbor 192.168.24.2 remote-as 23
R4(config-router)#neighbor 192.168.34.3 remote-as 23
R4(config-router)#redistribute connected
R4(config-router)#end
R4#
```

Creating a route map

```
R3(config)#route-map MED-TEST permit
R3(config-router-map)#match ip address 1
R3(config-router-map)#set metric 500
R3(config-router-map)#ex
R3(config)#route-map MED-TEST permit 20
R3(config-router-map)#end
```

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#route-map MED-TEST permit
R3(config-route-map)#match ip address 1
R3(config-route-map)#set metric 500
R3(config-route-map)#ex
R3(config)#route-map MED-TEST permit 20
R3(config-route-map)#end
R3#
*Dec 13 15:29:47.211: %SYS-5-CONFIG_I: Configured from console by console
R3#show route-map
```

```
R3#show route-map
route-map MED-TEST, permit, sequence 10
  Match clauses:
    ip address (access-lists) : 1
  Set clauses:
    metric 500
  Policy routing matches: 0 packets, 0 bytes
route-map MED-TEST, permit, sequence 20
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
```

Creating a access list

```
R3#conf t
R3(config)#access-list 1 permit host 4.4.4.4
R3(config)#end
```

R3#show access-list

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#access-list 1 permit host 4.4.4.4
R3(config)#end
R3#
*Dec 13 15:30:51.959: %SYS-5-CONFIG_I: Configured from console by console
R3#show access-list
Standard IP access list 1
  10 permit 4.4.4.4
```

Applying the created route-map to bgp configuration.

```
R3#conf t
R3(config)#router bgp 23
R3(config)#neighbor 192.168.13.1 route-map MED-TEST out
R3(config)#end
```

R3#show ip bgp

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router bgp 23
R3(config-router)#neighbor 192.168.13.1 route-map MED-TEST out
R3(config-router)#end
R3#
*Dec 13 15:32:00.543: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip bgp
BGP table version is 4, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

      Network          Next Hop            Metric LocPrf Weight Path
* >  3.3.3.0/24      0.0.0.0            0        32768 ?
* >  192.168.13.0   0.0.0.0            0        32768 ?
* >  192.168.34.0   0.0.0.0            0        32768 ?
R3#
```

R1#show ip bgp

```
R1#clear ip bgp * soft in
R1#show ip bgp
BGP table version is 4, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

      Network          Next Hop            Metric LocPrf Weight Path
* >  1.1.1.0/24      0.0.0.0            0        32768 ?
* >  192.168.2.0    0.0.0.0            0        32768 ?
* >  192.168.13.0   0.0.0.0            0        32768 ?
R1#
```

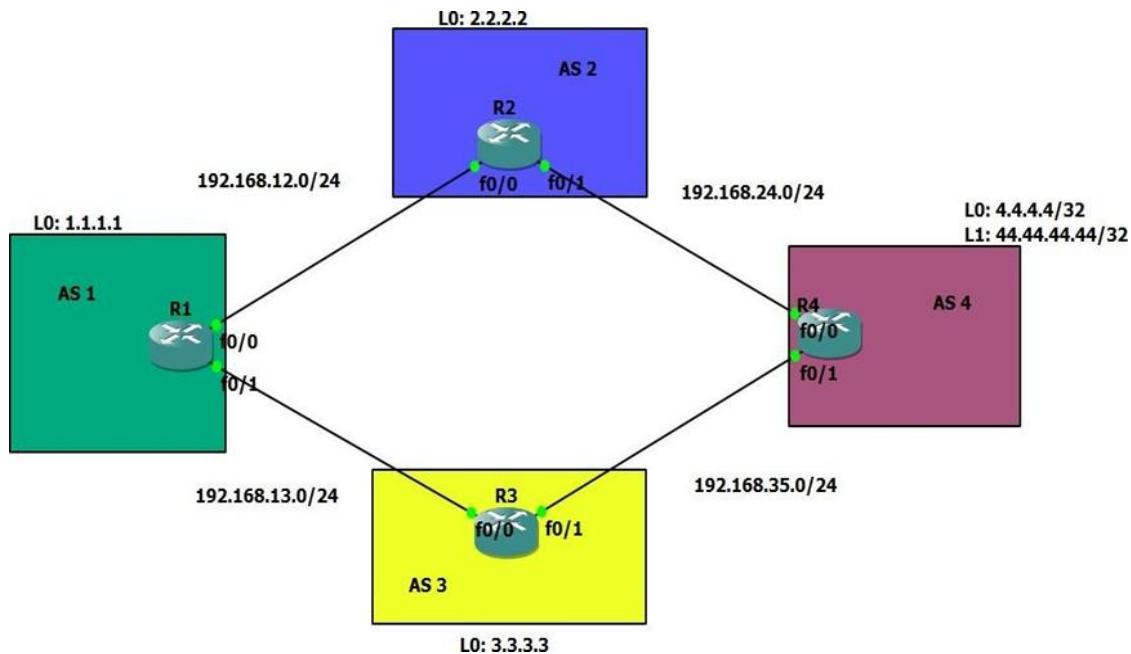
4d) Aim:- Implement the Concept of BGP Path Attribute- Local reference.

Software Used:- GNS 3.

Theory:- BGP (Border Gateway Protocol) uses path attributes to convey information about the properties and preferences of routes, and one significant concept within this framework is the "Local Preference" attribute. Local Preference is a well-known path attribute that is used primarily within an Autonomous System (AS) to influence route selection among multiple exit points. It is communicated via the BGP Update messages and is a way to specify which exit point is preferred for outbound traffic.

Implementation:-

Here is the Topology on which we did the experiment



Interface configuration for R1

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int fa 0/0
R1(config-if)#ip add 192.168.12.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:00:49.635: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:00:50.635: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#int fa 0/1
R1(config-if)#ip add 192.168.13.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:01:09.435: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:01:10.435: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1(config)#int Loopback0
R1(config-if)#ip-
*Mar 1 00:01:27.571: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip add 1.1.1.1 255.255.255.255
R1(config-if)#end

```

Interface configuration for R2

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int fa 0/0
R2(config-if)#ip add 192.168.12.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:01:49.183: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:50.183: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#int fa 0/1
R2(config-if)#ip add 192.168.24.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:02:33.107: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:02:34.107: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config)#int Loopback0
R2(config-if)#i
*Mar 1 00:02:57.975: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip add 2.2.2.2 255.255.255.255
R2(config-if)#end
R2#

```

Interface configuration for R3

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int fa 0/0
R3(config-if)#ip add 192.168.13.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
*Mar 1 00:04:56.175: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:04:57.175: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#ex
R3(config)#int fa 0/1
R3(config-if)#ip add 192.168.13.3 255.255.255.0
% 192.168.13.0 overlaps with FastEthernet0/0
R3(config-if)#ip add 192.168.35.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#in
*Mar 1 00:08:04.155: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:08:05.155: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R3(config)#int Loopback0
R3(config-if)#ip ad
*Mar 1 00:08:17.367: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip add 3.3.3.3 255.255.255.255
R3(config-if)#end
R3#

```

Interface configuration for R4

```
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#int fa 0/0
R4(config-if)#ip add 192.168.24.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#ex
R4(config)#
*Mar 1 00:08:44.575: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:08:45.575: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R4(config)#int fa 0/1
R4(config-if)#ip add 192.168.35.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#ex
*Mar 1 00:09:45.047: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:09:46.047: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R4(config-if)#ex
R4(config)#int Loopback0
R4(config-if)#ip a
*Mar 1 00:09:58.775: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R4(config-if)#ip add 4.4.4.4 255.255.255.255
R4(config-if)#exit
R4(config)#int Loopback1
R4(config-if)#
*Mar 1 00:10:36.919: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R4(config-if)#ip add 44.44.44.44 255.255.255.255
R4(config-if)#ex
```

BGP configuration of R1:

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router bgp 1
R1(config-router)#neigh
R1(config-router)#neighbor 3.3.3.3 remot
R1(config-router)#neighbor 3.3.3.3 remote-as 3
R1(config-router)#neighbor 3.3.3.3 upda
R1(config-router)#neighbor 3.3.3.3 update-source loo
R1(config-router)#neighbor 3.3.3.3 update-source loopback 0
R1(config-router)#neighbor 3.3.3.3 eb
R1(config-router)#neighbor 3.3.3.3 ebgp-multihop 2
R1(config-router)#neighbor 2.2.2.2 remote-as 1
R1(config-router)#neighbor 2.2.2.2 upd
R1(config-router)#neighbor 2.2.2.2 update-source loo
R1(config-router)#neighbor 2.2.2.2 update-source loopback 0
R1(config-router)#neighbor 2.2.2.2 nex
R1(config-router)#neighbor 2.2.2.2 next-hop-s
R1(config-router)#neighbor 2.2.2.2 next-hop-self
R1(config-router)#end
```

BGP configuration of R2:

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router bgp 1
R2(config-router)#neigh
R2(config-router)#neighbor 1.1.1.1 rmo
R2(config-router)#neighbor 1.1.1.1 re
R2(config-router)#neighbor 1.1.1.1 remot
R2(config-router)#neighbor 1.1.1.1 remote-as 1
R2(config-router)#neighbor 1.1.1.1 upd
R2(config-router)#neighbor 1.1.1.1 update-source loopb
R2(config-router)#neighbor 1.1.1.1 update-source loopback 0
R2(config-router)#neighbor 1.1.1.1 nex
R2(config-router)#neighbor 1.1.1.1 next-hop-s
R2(config-router)#neighbor 1.1.1.1 next-hop-self
R2(config-router)#neighbor 4.4.4.4 remote-as 4
R2(config-router)#neighbor 4.4.4.4 up
R2(config-router)#neighbor 4.4.4.4 update-source loo
R2(config-router)#neighbor 4.4.4.4 update-source loopback 0
R2(config-router)#neighbor 4.4.4.4 eb
R2(config-router)#neighbor 4.4.4.4 ebgp-multihop 2
R2(config-router)#end
R2#

```

BGP configuration of R3:

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router bgp 3
R3(config-router)#neig
R3(config-router)#neighbor 1.1.1.1 remo0
R3(config-router)#neighbor 1.1.1.1 remo
R3(config-router)#neighbor 1.1.1.1 remot6
R3(config-router)#neighbor 1.1.1.1 remote
R3(config-router)#neighbor 1.1.1.1 remote-as 1
R3(config-router)#neighbor 1.1.1.1 up
R3(config-router)#neighbor 1.1.1.1 update-source loo
R3(config-router)#neighbor 1.1.1.1 update-source loopback 0
R3(config-router)#neig
R3(config-router)#neighbor 1.1.1.1 ebg
R3(config-router)#neighbor 1.1.1.1 ebgp-multihop 2
R3(config-router)#
R3(config-router)#neigh
R3(config-router)#neighbor 4.4.4.4 remot
R3(config-router)#neighbor 4.4.4.4 remote-as 4
R3(config-router)#neighbor 4.4.4.4 up
R3(config-router)#neighbor 4.4.4.4 update-source loo
R3(config-router)#neighbor 4.4.4.4 update-source loopback 0
R3(config-router)#neighbor 4.4.4.4 ebg
R3(config-router)#neighbor 4.4.4.4 ebgp-multihop 2
R3(config-router)#end
R3#

```

```
R4(config)#router bgp 4
R4(config-router)#neigh
R4(config-router)#neighbor 3.3.3.3 remo
R4(config-router)#neighbor 3.3.3.3 remot
R4(config-router)#neighbor 2.2.2.2 remote-as 1
R4(config-router)#neighbor 2.2.2.2 upd
R4(config-router)#neighbor 2.2.2.2 update-source loop
R4(config-router)#neighbor 2.2.2.2 update-source loopback 0
R4(config-router)#neighbor 2.2.2.2 ebg
R4(config-router)#neighbor 2.2.2.2 ebgp-multihop 2
R4(config-router)#
R4(config-router)#neighbor 3.3.3.3 remote-as 3
R4(config-router)#neighbor 3.3.3.3 update-source loopback 0
R4(config-router)#neighbor 3.3.3.3 ebgp-multihop 2
R4(config-router)#end
R4#
```

Static Routes in R1:

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip route 3.3.3.3 255.255.255.255 fa 0/1
R1(config)#
R1(config)#ip route 2.2.2.2 255.255.255.255 fa 0/0
R1(config)#[
```

Static Routes in R2:

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#ip route 4.4.4.4 255.255.255.255 fa 0/1
R2(config)#ip route 1.1.1.1 255.255.255.255 fa 0/1
R2(config)#[
```

Static Routes in R3:

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#ip route 1.1.1.1 255.255.255.255 fa 0/0
R3(config)#ip route 4.4.4.4 255.255.255.255 fa 0/1
R3(config)#[
```

Static Routes in R4:

```
Mar 1 00:50:52.105 %SYS-5-CONFIG_I: Configured from console
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#ip route 2.2.2.2 255.255.255.255 fa 0/0
R4(config)#ip route 3.3.3.3 255.255.255.255 fa 0/1
R4(config)#[
```

All bgp routers form their neighborship

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
2.2.2.2	4	1	4	4	1	0	0	00:00:29	0
3.3.3.3	4	3	17	17	1	0	0	00:13:57	0

Redistributing connected interface

```
R1(config)#router bgp 1
R1(config-router)#redis
R1(config-router)#redistribute conn
R1(config-router)#redistribute connected
R1(config-router)#ex
R1(config)#[
```

```

Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router bgp 1
R2(config-router)#redistri
R2(config-router)#redistribute conn
R2(config-router)#redistribute connected
R2(config-router)#ex
R2(config)#

```



```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router bgp 3
R3(config-router)#redis
R3(config-router)#redistribute conn
R3(config-router)#redistribute connected
R3(config-router)#ex
R3(config)#

```



```

R4(config)#router bgp 4
R4(config-router)#redi
R4(config-router)#redistribute conn
R4(config-router)#redistribute connected
R4(config-router)#ex
R4(config)#

```

After redistributing connected routes.

```

R1#show ip bgp summary | begin Neighbor
Neighbor      V     AS MsgRcvd MsgSent    TblVer  InQ OutQ Up/Down  State/PfxRcd
2.2.2.2        4     1     15     23          20     0     0 00:00:29       6
3.3.3.3        4     3     33     30          20     0     0 00:21:57       6
R1#

```

```

R1#show ip bgp 4.4.4.4
BGP routing table entry for 4.4.4.4/32, version 18
Paths: (2 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
    4
      2.2.2.2 from 2.2.2.2 (2.2.2.2)
        Origin incomplete, metric 0, localpref 100, valid, internal, best
      3 4
        3.3.3.3 from 3.3.3.3 (3.3.3.3)
          Origin incomplete, localpref 100, valid, external
R1#

```

```

R1#show ip bgp 44.44.44.44
BGP routing table entry for 44.44.44.44/32, version 19
Paths: (2 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
    4
      2.2.2.2 from 2.2.2.2 (2.2.2.2)
        Origin incomplete, metric 0, localpref 100, valid, internal, best
      3 4
        3.3.3.3 from 3.3.3.3 (3.3.3.3)
          Origin incomplete, localpref 100, valid, external
R1#

```

```
R2#show ip bgp 4.4.4.4
BGP routing table entry for 4.4.4.4/32, version 15
Paths: (1 available, best #1, table Default-IP-Routing-Table, RIB-failure(17))
  Advertised to update-groups:
    1
    4
      4.4.4.4 from 4.4.4.4 (44.44.44.44)
        Origin incomplete, metric 0, localpref 100, valid, external, best
R2#
R2#show ip bgp 44.44.44.44
BGP routing table entry for 44.44.44.44/32, version 12
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
    4
      4.4.4.4 from 4.4.4.4 (44.44.44.44)
        Origin incomplete, metric 0, localpref 100, valid, external, best
R2#
R2#show ip bgp 3.3.3.3
BGP routing table entry for 3.3.3.3/32, version 29
Paths: (2 available, best #1, table Default-IP-Routing-Table)
Flag: 0x820
  Advertised to update-groups:
    2
    3
      1.1.1.1 from 1.1.1.1 (1.1.1.1)
        Origin incomplete, metric 0, localpref 100, valid, internal, best
    4 3
      4.4.4.4 from 4.4.4.4 (44.44.44.44)
        Origin incomplete, localpref 100, valid, external
R2#
```

Configuring local preference using Route Map on R1

```
R1(config)#route-map LOCAL-PREFERENCE permit 10
R1(config-route-map)#set local preference 7500
% Invalid input detected at '^' marker.

R1(config-route-map)#set local preference 7500
% Invalid input detected at '^' marker.

R1(config-route-map)#set local=preference 7500
% Invalid input detected at '^' marker.

R1(config-route-map)#set local-preference 7500
R1(config-route-map)#match ip address 1
R1(config-route-map)#exit
R1(config)#
R1(config)#access-list 1 permit 4.4.4.4 0.0.0.0
```

BGP configuration to apply route-map to neighbor:

```
R1(config)#router bgp 1
R1(config-router)#
R1(config-router)#neigh
R1(config-router)#neigh
R1(config-router)#neighbor 3.3.3.3 rout
R1(config-router)#neighbor 3.3.3.3 route-map LOC
R1(config-router)#neighbor 3.3.3.3 route-map LOCA
R1(config-router)#neighbor 3.3.3.3 route-map LOCAL-PREFERENCE in
R1(config-router)#end
R1#
*Mar  1 01:28:51.207: %SYS-5-CONFIG_I: Configured from console by cor
R1#
*Mar  1 01:28:55.799: %BGP-5-ADJCHANGE: neighbor 2.2.2.2 Down BGP Not
R1#cle
*Mar  1 01:28:55.799: %BGP-3-NOTIFICATION: sent to neighbor 2.2.2.2 4
R1#clear ip bgp
*Mar  1 01:29:22.603: %BGP-5-ADJCHANGE: neighbor 2.2.2.2 Up
R1#clear ip bgp * soft
```

Output:

```
R1#show ip bgp 4.4.4.4
BGP routing table entry for 4.4.4.4/32, version 59
Paths: (2 available, best #2, table Default-IP-Routing-Table)
Flag: 0x820
    Advertised to update-groups:
        2
        4
            2.2.2.2 from 2.2.2.2 (2.2.2.2)
                Origin incomplete, metric 0, localpref 100, valid, internal
            3 4
                3.3.3.3 from 3.3.3.3 (3.3.3.3)
                    Origin incomplete, localpref 7500, valid, external, best
R1#show ip bgp 44.44.44.44
BGP routing table entry for 44.44.44.44/32, version 55
Paths: (1 available, best #1, table Default-IP-Routing-Table)
    Advertised to update-groups:
        1
        4
            2.2.2.2 from 2.2.2.2 (2.2.2.2)
                Origin incomplete, metric 0, localpref 100, valid, internal, best
R1#
```

